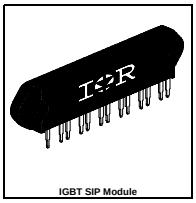
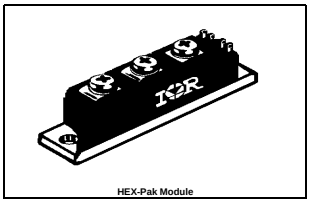
The IGBT SIP & HEXPak Navigator

Effective 8 September,

EXISTING Products	NEW Products	UPCOMING Products	POTENTIAL Products
	released to production in last 6-9 months	to be released within next 3-4 months	no current plans... see bus.mgmt.



IGBT SIP Module



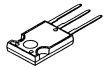
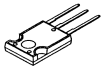
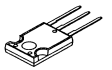
HEX-Pak Module

Voltage	Speed	Ic @ 100 degC	3 Phase Bridge
600V high effic.	Ultra-Fast	4 A	CPV362M4U 50044
	approx.	7 A	CPV363M4U 50039
	8 ~ 60 kHz	10 A	CPV364M4U 50041
	Fast	5 A	CPV362M4F 50046
	approx.	9 A	CPV363M4F 50038
	1 ~ 8 kHz	15 A	CPV364M4F 50040
600V for Motor Drives	Ultra-Fast for 8 ~ 25 kHz	3 A	CPV362M4K 50045
		6 A	CPV363M4K 50043
		13 A	CPV364M4K 50042

Voltage	Rds(on)	Ic @ 25 degC	Parallel Chip	Half Bridge
60 V	0.01	120 A		IRFK2D054 IRFK2F054 82790
	0.005	150 A	IRFK4H054 IRFK4J054 27103	
	0.003	350 A	IRFK6H054 IRFK6J054 27128	
100 V	0.028	72 A		IRFK2D150 IRFK2F150 82791
	0.02	125 A		IRFK3D150 IRFK3F150 82797
	0.014	145 A	IRFK4H150 IRFK4J150 27104	
	0.01	150 A	IRFK6H150 IRFK6J150 27110	
200 V	0.043	54 A		IRFK2D250 IRFK2F250 82792
	0.03	70 A		IRFK3D250 IRFK3F250 82798
	0.021	108 A	IRFK4H250 IRFK4J250 27105	
	0.015	140 A	IRFK6H250 IRFK6J250 27111	
400 V	0.15	25 A		IRFK2D350 IRFK2F350 82793
	0.1	37 A		IRFK3D350 IRFK3F350 82799
	0.075	50 A	IRFK4H350 IRFK4J350 27106	
	0.05	75 A	IRFK6H350 IRFK6J350 27112	
500 V	0.2	22 A		IRFK2D450 IRFK2F450 82794
	0.135	33 A		IRFK3D450 IRFK3F450 27100
	0.1	44 A	IRFK4H450 IRFK4J450 27107	
	0.067	66 A	IRFK6H450 IRFK6J450 27113	
600V	0.35	18 A		IRFK2DC50 IRFK2FC50 82795
	0.23	24 A		IRFK3DC50 IRFK3FC50 27101
	0.175	35 A	IRFK4HC50 IRFK4JC50 27108	
	0.1	48 A	IRFK6HC50 IRFK6JC50 27114	
800 V	0.6	12 A		IRFK2DE50 IRFK2FE50 82796
	0.3	26 A	IRFK4HE50 IRFK4JE50 27109	

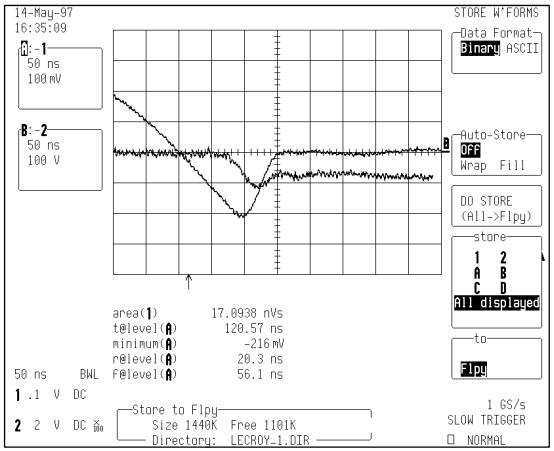
New Fast Recovery Diodes in package D-Pak, D² Pak, TO-220 & TO-247

QUIET***IR*** *Series 600V, 60ns*

IF (AVG)	8A	10A	10A	20A	20A	20A	30A	40A	60A	60A	80A
Package Style											
Voltage Grade	D-Pak	D²-Pak	TO-220AC	D²-Pak	TO-220AC	TO-220 Full Pak	TO-247 3pins	TO-247	TO-247	TO-247 3pins	TO-247 3pins
200	*8EWF02S*	*10ETF02S*	*10ETF02*	*20ETF02S*	*20ETF02*	*20ETF02FP*	*30CPF02*	*40EPF02*	*60EPF02*	*60CPF02*	*80EPF02*
	1,1V 60ns	*1,1V 60ns*	*1,1V 60ns*	*1,3V 60ns*	*1,3V 60ns*	*1,3V 60ns*	*1,4V 60ns*	*1,25V 60ns*	*1,3V 70ns*	*1,3V 70ns*	*1,2V 70ns*
400	*8EWF04S*	*10ETF04S*	*10ETF04*	*20ETF04S*	*20ETF04*	*20ETF04FP*	*30CPF04*	*40EPF04*	*60EPF04*	*60CPF04*	*80EPF04*
	1,1V 60ns	*1,1V 60ns*	*1,1V 60ns*	*1,3V 60ns*	*1,3V 60ns*	*1,3V 60ns*	*1,4V 60ns*	*1,25V 60ns*	*1,3V 70ns*	*1,3V 70ns*	*1,2V 70ns*
600	*8EWF06S*	*10ETF06S*	*10ETF06*	*20ETF06S*	*20ETF06*	*20ETF06FP*	*30CPF06*	*40EPF06*	*60EPF06*	*60CPF06*	*80EPF06*
	1,1V 60ns	*1,1V 60ns*	*1,1V 60ns*	*1,3V 60ns*	*1,3V 60ns*	*1,3V 60ns*	*1,4V 60ns*	*1,25V 60ns*	*1,3V 70ns*	*1,3V 70ns*	*1,2V 70ns*

Vf @ IF (AVG) , T J =25°C, trr @ IF = 1A, -di/dt = 100A/µs, Vr = -30V

Typical Reverse Recovery Waveform



QUIET***IR*** is a new family of power semiconductors developed to increase active noise immunity but maintain the "Fast" recovery characteristics and meet the new Electro-Magnetic Interference (EMI) regulations. During the electrical energy conversion process, some of the electrical energy is not applied to the load but rather transformed in some other disturbing form like heat or noise. These undesirable effects are similar in the way mechanical equipment creates acoustic noise and heat. Reduction of this noise improves energy efficiency and reduces electro-magnetic interference. Typical application characteristics of QUIET***IR*** are:

- **Soft recovery**
- **Low forward voltage drops**

Then Applications may include:

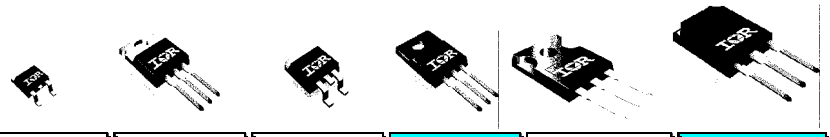
- **Welding output diodes**
- **Low EMI Rectifiers for Input Bridge**
- **Low EMI Rotating Rectifiers for field winding in alternators**

*QUIET**IR*** *italic*
SMALL***IR*** underline

EXISTING Products | NEW Products released to production in last 6-9 months | UPCOMING Products to be released within next 3-4 months | POTENTIAL Products no current plans... see bus.mgmt.

The IR IGBT Navigator

Effective 6 October, 1999



Voltage	Speed	Ic @100C	Change	D-Pak Discrete	TO-220 Discrete (CoPack)	D²Pak/TO-262 Discrete (CoPack)	TO-220 Fullpak	TO-247 Discrete (CoPack)	Super247 Discrete (CoPack)
Highest-Efficiency:									
250V high effic.	Low-Vceon 0 ~ 10 kHz	55 A						IRG4P254S 91591	
		~5A							
	Warp Speed 60 ~ 150 kHz	6.5 A			IRG4BC20W 91652		IRGIBC20W 91785		
		12A			IRG4BC30W 91629	IRG4BC30W-S 91790	IRG4IBC30W 91791	IRG4PC30W 91628	
		20A			IRG4BC40W 91654			IRG4PC40W 91656	
		27A						IRG4PC50W 91657	
	Ultra-Fast approx. 8 ~ 60 kHz	5.0 A	Y	IRG4RC10U 91572	IRG4BC10UD 91677		IRG4IBC10UD 2/99 10/99		
		6.5 A			IRG4BC20U(D) 92448 (92449)		IRG4IBC20UD 91752		
		12 A			IRG4BC30U(D) 91452 (91453)	IRG4BC30U-S 91803	IRG4IBC30UD 91753	IRG4PC30U(D) 91461(91462)	
		20 A			IRG4BC40U 91456			IRG4PC40U(D) 91456 (91467)	
		27 A						IRG4PC50U(D) 91470 (91471)	
		50 A							
600V high effic.		60 A	Y						IRG4PSC71U(D) 91681 (91682)10/99
	Fast approx. 1 ~ 8 kHz	4.5 A							
		9.0 A			IRG4BC20F(D) 91602 (91601)		IRG4IBC20FD 91750		
		17 A			IRG4BC30F(D) 91450 (91451)		IRG4IBC30FD 91751	IRG4PC30F(D) 91459 (91460)	
		27 A			IRG4BC40F 91454			IRG4PC40F(D) 91463 (91464)	
		39 A						IRG4PC50F(D) 91468 (91469)	
	Standard/ low Vceon approx. 0 ~ 1 kHz	8.0 A		IRG4RC10S 91732	IRG4BC10S(D) 91786 91784				
		10 A			IRG4BC20S(D) 91597 (91793)	IRG4BC20SD-S 91794			
		18 A			IRG4BC30S 91593			IRG4PC30S 91586	
		31 A			IRG4BC40S (92-0065) 91455			IRG4PC40S 91465	
		41 A						IRG4PC50S 91581	

Voltage	Speed	Ic @100C	Change	D-Pak Discrete	TO-220 Discrete (CoPack)	D²Pak/TO-262 Discrete (CoPack)	TO-220 Fullpak	TO-247 Discrete (CoPack)	Super247 Discrete (CoPack)
900V high effic.	Warp Speed 20 ~ 100 kHz	28 A						IRG4PF50W(D) 91710 (91788)	
1200V high effic.	Ultra-Fast approx. 5 ~ 40 kHz	16 A						IRG4PH40U(D) 91612 (91621)	
		20 A	Y					IRGP20B120UD-E Now 11/99	
		24 A						IRG4PH50U(D) 91574 (91573)	
		42 A							
	Standard (low sat) 0 ~ 1 kHz	33A						IRG4PH50S 91712	

Short-Circuit-Rated:

600V for Motor Drives	Ultra-Fast for 8 ~ 25 kHz motors	5.0 A			IRG4BC10K(D) 91733 (91734)				
		9.0 A			IRG4BC20K(D) 91600 (91599)	IRG4BC20K(D)-S 91620 (91598)	IRG4IBC20KD 91689		
		16 A			IRG4BC30K(D) 91596 (91595)	IRG4BC30K(D)-S 91619 (91594)	IRG4IBC30KD 91690	IRG4PC30K(D) 91588 (91587)	
		25 A			IRG4BC40K 91592			IRG4PC40K(D) 91585 (91584)	
		30 A						IRG4PC50K(D) 91583 (91582)	
		tbd							
		60 A	Y						IRG4PSC71K(D) 91683 (91684)10/99
1200V for Motor Drives	Ultra-Fast for 4~20 kHz motors	5 A	Y			IRG4BH20K-S/L 5/99 10/99		IRG4PH20K(D) 91776 (91777)	
		10 A						IRG4PH30K(D) 91580 (91579)	
		15 A						IRG4PH40K(D) 91578 (91577)	
		24 A						IRG4PH50K(D) 91576 (91575)	
		30 A	Y					IRGP30B120KD-E Now 11/99	
		42 A	Y						IRG4PSH71K(D) 91687 (91688) 7/99 10/99

Ignition IGBT:

400V	Low-Vceon	14 A	Y			IRGS14C40L Now 12/99			

KEY:

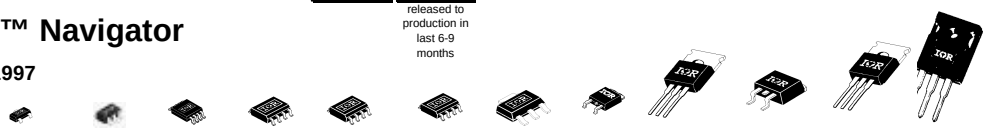
Part Number	
FOD document #	
Date for SAMPLES	Date for PROD'N

**** = not recommended for new designs***

COLOR CODING: **EXISTING Products** | **NEW Products** released to production in last 6-9 months

The HEXFET™ Navigator

Effective 15 April, 1997

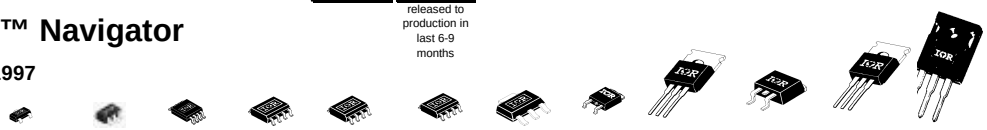


BVdss	Rds(on)	gate, spd	Micro3	Micro6	single/dual Micro8	Single SO-8	Dual SO-8	SO-8 FETKY	SOT-223	DPak	TO-220	D2Pak	TO-220 FullPak	TO-247 / TO-3P
20V	.250-.300	LL	IRLML2402 91257											
	0.135	LL		IRLMS1902 91540	IRF7501/7 91265/69									
	0.050	LL					IRF7301/7 91238/42							
	0.035	LL			IRF7601 91261									
	0.026	LL					IRF7311 91435							
	0.022	LL				IRF7401 91244								
		LL												
-20 V	0.600	LL	IRLML6302 91259											
	0.200	LL		IRLMS6702 91414	IRF7504/7 91267/69									
	0.090	LL					IRF7304/7 91240/42	IRF7422D2 91412						
	0.090	LL			IRF7604 91263									
	0.053	LL					IRF7314 91436							
	0.040	LL				IRF7404 91246								
		LL				IRF7414 2/97 3/97								
30 V	0.250	L	IRLML2803 91258											
	0.100	L		IRLMS1503 91508	IRF7503/9 91266/70		IRF7101/5 90871/97 IRF9956/2 91559/61							
	0.050	L					IRF7303/9 91239/43							
	0.040	L								IRLR2703 91335				
	.03-.035	L			IRF7603 91262	IRF7201 91100 IRF9410 91562 4/97 5/97		IRF7421D1 91411						
	0.026	L					IRF7313 91480 IRF7319 91606 4/97 6/97							
	.026-.031	L								IRLR3303 91316	IRL3303 91322	IRL3303S 91323		
	.026-.031	L							IRLL3303 91379					
	0.022	L				IRF7403 91245								
	.014-.019	L								IRLR3103 91333	IRL3103 91337	IRL3103S 91338		
	0.011	L				IRF7413 91330								
	0.010	L,HF												
	0.007	L									IRL2203N 91366	IRL2203NS 91367	IRLI2203N 91378	
	0.006	L									IRL3803 91301	IRL3803S 91319	IRLI3803 91320	
-30 V	0.600	L	IRLML5103 91260											
	0.200	L		IRLMS5703 91413	IRF7506/9 91268/70		IRF7104/5 91096/7 IRF9953/2							
	0.100	L					IRF7306/9 91242/43							
	0.070	L				*IRF7205* 91104*								
	0.060	L			IRF7606 91264	IRF7204 91103 IRF9430/5								
	0.053	L					IRF7316/9 91505/606 4/97 6/97							
	0.045	L				IRF7406 91247								
	0.020	L				IRF7416 91356								
		L												

COLOR CODING: EXISTING Products | NEW Products released to production in last 6-9 months

The HEXFET™ Navigator

Effective 15 April, 1997

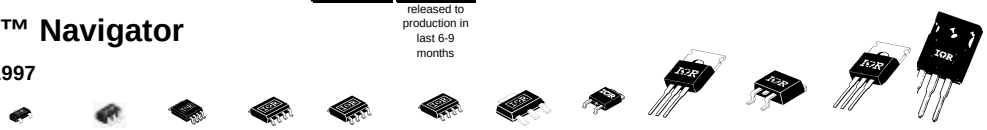


BVdss	Rds(on)	gate, spd	Micro3	Micro6	single/dual Micro8	Single SO-8	Dual SO-8	SO-8 FETKY	SOT-223	DPak	TO-220	D2Pak	TO-220 FullPak	TO-247 / TO-3P
55 V	0.200								IRFL014N					
	.130-.200	L					IRF7103 91095		IRLL014N 91499					
	0.070									IRFR024N 91336	IRFZ24N 91354	IRFZ24NS 91355	IRFIZ24N 91501	
	.060-.065	L								IRLR024N 91363	IRLZ24N 91357	IRLZ24NS 91358	IRLIZ24N 91344	
	0.040									IRFR4105 91302	IRFZ34N 91276	IRFZ34NS 91311	IRFIZ34N 91489	
	0.040								IRFL4105 91381					
	0.040	L							IRLL2705 91380	IRLR2705 91317	IRLZ34N 91307	IRLZ34NS 91308	IRLIZ34N 91329	
	0.024									IRFR1205 91318	IRFZ44N 91303	IRFZ44NS 91315	IRFIZ44N 91403	
	0.022	L								IRLR2905 91334	IRLZ44N 91346	IRLZ44NS 91347	IRLIZ44N 91498	
	0.020										IRFZ46N 91277	IRFZ46NS 91305	IRFIZ46N 91306	IRFP044N 91410
	0.016										IRFZ48N 91406	IRFZ48NS 91408	IRFIZ48N 91407	IRFP048N 91409
	0.012										IRF1010N 91278	IRF1010NS 91372	IRFI1010N 91373	IRFP054N 91382
	0.010	L									IRL3705N 91370	IRL3705NS 91502	IRLI3705N 91369	
	0.008										IRF3205 91279	IRF3205S 91304	IRFI3205 91374	IRFP064N 91383
	0.008	L									IRL2505 91325	IRL2505S 91326	IRLI2505 91327	
-55 V	0.175										IRF9Z24N 91484			
	0.110										IRF9Z34N 92001		IRFI9Z34N 91489 6/97 7/97	
	0.060									IRFR5305 91402	IRF5305 91385	IRF5305S 91386		
	0.020										IRF4905 91280	IRF4905S 91478	IRFI4905 91526 6/97 7/97	
60V	0.200									IRFR014* 90701	IRFZ14* 90507	IRFZ14S* 90890	IRFIZ14G* 90859	
	0.200	L								IRLR014* 90624	IRLZ14* 90556	IRLZ14S* 90903	IRLIZ14G* 90846	
	0.044											IRFZ34S* 90892		
	0.044	L										IRLZ34S* 90905		
-60V	0.140												IRFI9Z34G* 90842	
	0.285												IRFI9Z24G* 90841	
	0.500									IRFR9014* 90654	IRF9Z14* 90736	IRF9Z14S* 90911	IRFI9Z14G* 90840	
100 V	0.540									IRF/LR110 90524/633	IRF510 90325	IRF/L510S 90895/907	IRFI510G 90829	
	.200-.210								IRFL4310 91368	IRFR120N 91365	IRF520N 91339	IRF520NS 91340	IRFI520N 91362	
	0.180	L								IRLR120N	IRL520N 91494	IRL520NS 91494	IRLI520N 91496	
	0.110									IRFR3910 91364	IRF530N 91351	IRF530NS 91352	IRFI530N 91353	
	0.100	L									IRL530N 91348	IRL530NS 91349	IRLI530N 91350	
	0.052										IRF540N 91341	IRF540NS 91342	IRFI540N 91361	IRFP140N 91343
	0.044	L									IRL540N 91495	IRL540NS 91495	IRLI540N 91497	
	0.036										IRF1310N 91504	IRF1310NS 91514	IRFI1310N	IRFP150N 91503
	0.028										IRF3710 91309	IRF3710S 91310	IRFI3710 91387	IRFP3710 91490
	0.026	L									IRL2910 91375	IRL2910S 91376		

COLOR CODING: **EXISTING Products** | **NEW Products** released to production in last 6-9 months

The HEXFET™ Navigator

Effective 15 April, 1997

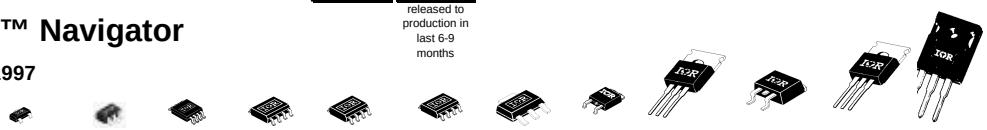


BVdss	Rds(on)	gate, spd	Micro3	Micro6	single/dual Micro8	Single SO-8	Dual SO-8	SO-8 FETKY	SOT-223	DPak	TO-220	D2Pak	TO-220 FullPak	TO-247 / TO-3P
-100 V	0.200									IRFR9120N	IRF9520N	IRF9520NS	IRFI9520N 6/97 7/97	
											IRF9530N 91482	IRF9530NS	IRFI9530N 6/97 7/97	
	0.117										IRF9540N 91437	IRF9540NS 91483	IRFI9540N 91487 6/97 7/97	IRFP9140N 91492 3/97 3/97
	0.060										IRF5210 91434	IRF5210S 91405 March 97	IRFI5210 91404 6/97 7/97	
-150 V	0.290										IRF6215 91479			
200V	1.500									IRFR210 90526	IRF610 90326	IRF610S 90899		
	0.800									IRFR220 90525	IRF620 90317	IRF620S 90900	IRF/LI620G 90832/1235	
	0.400										IRF630 90309	IRF630S 90901	IRF/LI630G 90652/1236	
	0.180										IRF/L640 90374/1089	IRF640S 90902	IRF/LI640G 90649/1237	IRFP240 90444
	0.085													IRFP250 90443
	0.055													IRFP260 90755
-200V	0.500										IRF9640 90422	IRF9640S 90921	IRFI9640G 90839	IRFP9240 90481
	0.800										IRF9630 90352	IRF9630S 90920	IRFI9630G 90838	
	1.500									IRFR9220 90522	IRF9620 90351	IRF9620S 90919	IRFI9620G 90874	
	3.000									IRFR9210 90521	IRF9610 90350	IRF9610S 90918		
250V	0.075													IRFP264 90756
	0.140													IRFP254 90540
	0.280										IRF644 90527	IRF644S 91006	IRFI644G 90739	IRFP244 90588
	0.450										IRF634 90476	IRF634S 91005	IRFI634G 90738	
	1.100									IRFR224 90600	IRF624 90472	IRF624S 91004	IRFI624G 90833	
	2.000									IRFR214 90703	IRF614 90475	IRF614S 91003	IRFI614G 90831	
-250V	3.000													
	1.000												IRFI9634G 91488	
300 LC	0.750										IRF737LC 91314			
400V	0.200													IRFP360 90586
	0.300													IRFP350 90445
	0.550										IRF740 90375	IRF740S 91010	IRFI740G 90651	IRFP340 90456
	1.000										IRF730 90308	IRF730S 91009	IRFI730G 90650	
	1.800									IRFR320 90598	IRF720 90315	IRF720S 91008	IRFI720G 90834	
	3.600									IRFR310 90597	IRF710 90327	IRF710S 91007		
400 LC	0.200													IRFP360LC 91230
	0.300													IRFP350LC 91229
	0.550										IRF740LC 91068			
	0.550												IRFI740GLC 91209	
450V	0.350													IRFP354 90995
	0.630										IRF744 91000		IRFI744G 91002	IRFP344 90998
	1.200										IRF734 90999		IRFI734G 91001	

COLOR CODING: **EXISTING Products** | **NEW Products** released to production in last 6-9 months

The HEXFET™ Navigator

Effective 15 April, 1997

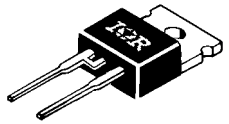
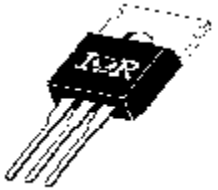


BVdss	Rds(on)	gate, spd	Micro3	Micro6	single/dual Micro8	Single SO-8	Dual SO-8	SO-8 FETKY	SOT-223	DPak	TO-220	D2Pak	TO-220 FullPak	TO-247 / TO-3P
500V	0.270													IRFP460 90512
	0.400													IRFP450 90458
	0.600													IRFP448 90595
	0.850										IRF840 90376	IRF840S 91013	IRFI840G 90642	IRFP440 90457
	1.500										IRF830 90311	IRF830S 91012	IRFI830G 90646	
	3.000									IRFR420 90599	IRF820 90324	IRF820S 91011	IRFI820G 90641	
500 LC	0.270													IRFP460LC 91232
	0.400													IRFP450LC 91231
	0.850										IRF840LC 91069			
	0.850												IRFI840GLC 91208	
600V	0.400													IRFPC60 90870
	0.600													IRFPC50 90656
	0.820													IRFPC48 90996
	1.200										IRFBC40 90506		IRFIBC40G 90852	IRFPC40 90511
	2.200										IRFBC30 90482		IRFIBC30G 90851	IRFPC30 90596
	4.400									IRFRC20 90637	IRFBC20 90623		IRFIBC20G 90850	
600 LC	0.400													IRFPC60LC 91234
	0.600													IRFPC50LC 91233
	1.200										IRFBC40LC 91070			
	1.200												IRFIBC40GLC 91211	
800V	1.200													IRFPE50 90573
	2.000													IRFPE40 90578
	3.000										IRFBE30 90613		IRFIBE30G 90854	IRFPE30 90612
	6.500										IRFBE20 90610		IRFIBE20G 90853	
900V	1.600													IRFPF50 90542
	2.500													IRFPF40 90580
	3.700										IRFBF30 90616		IRFIBF30G 90856	IRFPF30 90618
	8.000										IRFBF20 90607		IRFIBF20G 90855	
1000V	2.000													IRFPG50 90543
	3.500													IRFPG40 90576
	5.000										IRFBG30 90620			IRFPG30 90621
	11.000										IRFBG20 90604			

KEY: **Part Number / FOD document #** — Date for SAMPLES — Date for PROD'N

**** = not recommended for new designs***

TO-220 AND TO-247 PACKAGES

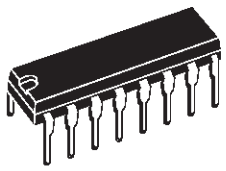
VOLTAGE PROCESS	6A TO 12A	15A TO 20A	10 TO 20A	25A TO 30A	30A	40A/60A
						
	TO-220AC		CENTER TAP TO-220AB		CENTER TAP TO-247AC	
15V OR'ING	—	19TQ015 [20266]	—	—	—	—
30V STANDARD	—	—	—	32CTQ030 [20267]	—	—
45V STANDARD	12TQ045 [20239]	20TQ045 [20056]	15CTQ045 [20240]	25CTQ045 [20242]	30CPQ045 [20297] MBR3045PT [20324]	40CPQ045 [20307]
45V HIGH TEMP	6TQ045 [20283] 10TQ045 [20057] MBR745 [20325] MBR1045 [20317]	18TQ045 [20178] MBR1645 [20319]	12TQ045 [20239] 20CTQ045 [20056] MBR1545CT [20318] MBR2045CT [20320]	30CTQ045 [20332] MBR2545CT	—	—
60V	—	—	—	30CTQ060 [20300]	30CPQ060 [20298]	40CPQ060 [20308]
100V	8TQ100 [20238]	—	16CTQ100 [20192] MBR20100CT [20321]	—	30CPQ100 [20333]	40CPQ100 [20309]
150V	—	—	10CTQ150 [20291]	—	30CPQ150 [20299]	—

Legend: Part Number [FAX-On-Demad Number]

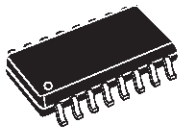
SG2525A
SG3525A

REGULATING PULSE WIDTH MODULATORS

- 8 TO 35 V OPERATION
- 5.1 V REFERENCE TRIMMED TO ± 1 %
- 100 Hz TO 500 KHz OSCILLATOR RANGE
- SEPARATE OSCILLATOR SYNC TERMINAL
- ADJUSTABLE DEADTIME CONTROL
- INTERNAL SOFT-START
- PULSE-BY-PULSE SHUTDOWN
- INPUT UNDERVOLTAGE LOCKOUT WITH HYSTERESIS
- LATCHING PWM TO PREVENT MULTIPLE PULSES
- DUAL SOURCE/SINK OUTPUT DRIVERS



DIP16

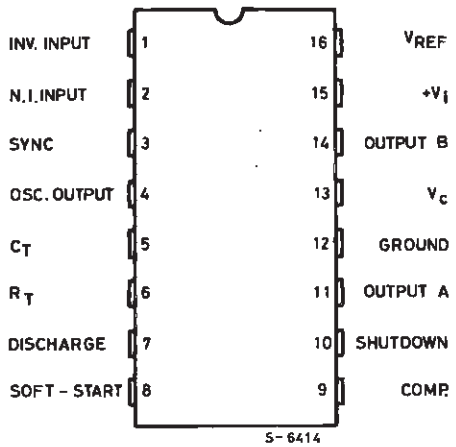


16(Narrow)

DESCRIPTION

The SG3525A series of pulse width modulator integrated circuits are designed to offer improved performance and lowered external parts count when used in designing all types of switching power supplies. The on-chip + 5.1 V reference is trimmed to ± 1 % and the input common-mode range of the error amplifier includes the reference voltage eliminating external resistors. A sync input to the oscillator allows multiple units to be slaved or a single unit to be synchronized to an external system clock. A single resistor between the C_T and the discharge terminals provide a wide range of dead time ad- justment. These devices also feature built-in soft-start circuitry with only an external timing capacitor required. A shutdown terminal controls both the soft-start circuity and the output stages, providing instantaneous turn off through the PWM latch with pulsed shutdown, as well as soft-start recycle with longer shutdown commands. These functions are also controlled by an undervoltage lockout which keeps the outputs off and the soft-start capacitor discharged for sub-normal input voltages. This lockout circuitry includes approximately 500 mV of hysteresis for jitter-free operation. Another feature of these PWM circuits is a latch following the comparator. Once a PWM pulses has been terminated for any reason, the outputs will remain off for the duration of the period. The latch is reset with each clock pulse. The output stages are totem-pole designs capable of sourcing or sinking in excess of 200 mA. The SG3525A output stage features NOR logic, giving a LOW output for an OFF state.

PIN CONNECTIONS AND ORDERING NUMBERS (top view)



Type	Plastic DIP	SO16
SG2525A	SG2525AN	SG2525AP
SG3525A	SG3525AN	SG3525AP

ABSOLUTE MAXIMUM RATINGS

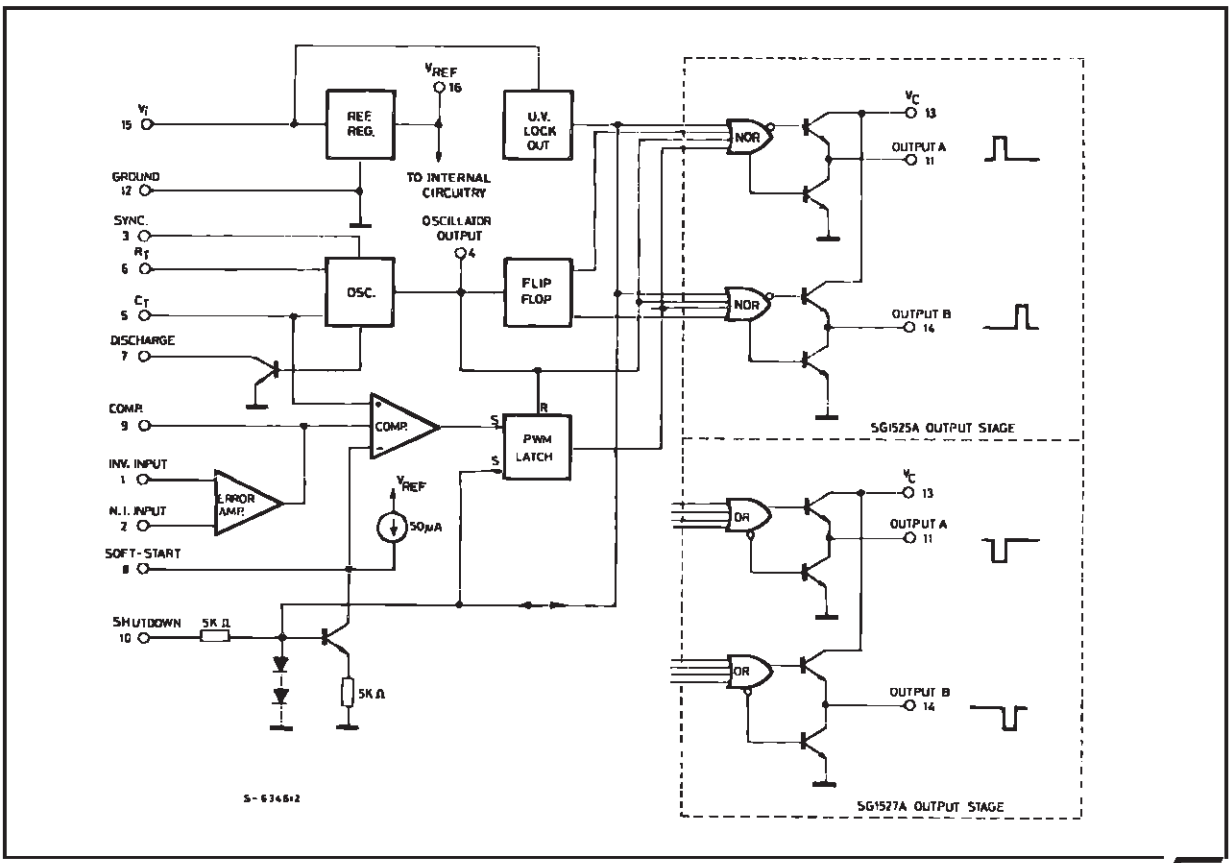
Symbol	Parameter	Value	Unit
V_i	Supply Voltage	40	V
V_C	Collector Supply Voltage	40	V
I_{OSC}	Oscillator Charging Current	5	mA
I_o	Output Current, Source or Sink	500	mA
I_R	Reference Output Current	50	mA
I_T	Current through C_T Terminal Logic Inputs Analog Inputs	5 – 0.3 to + 5.5 – 0.3 to V_i	mA V V
P_{tot}	Total Power Dissipation at T_{amb} = 70 °C	1000	mW
T_j	Junction Temperature Range	– 55 to 150	°C
T_{stg}	Storage Temperature Range	– 65 to 150	°C
T_{op}	Operating Ambient Temperature : **SG2525A** **SG3525A**	– 25 to 85 0 to 70	°C °C

THERMAL DATA

Symbol	Parameter		SO16	DIP16	Unit
$R_{th\ j\text{-}pins}$	Thermal Resistance Junction-pins	Max		50	°C/W
$R_{th\ j\text{-}amb}$	Thermal Resistance Junction-ambient	Max		80	°C/W
$R_{th\ j\text{-}alumina}$	Thermal Resistance Junction-alumina (*)	Max	50		°C/W

* Thermal resistance junction-alumina with the device soldered on the middle of an alumina supporting substrate measuring 15 × 20 mm ; 0.65 mm thickness with infinite heatsink.

BLOCK DIAGRAM



ELECTRICAL CHARACTERISTICS

(V# i = 20 V, and over operating temperature, unless otherwise specified)

Symbol	Parameter	Test Conditions	SG2525A			SG3525A			Unit
			Min.	Typ.	Max.	Min.	Typ.	Max.	
REFERENCE SECTION									
V_{REF}	Output Voltage	T_j = 25 °C	5.05	5.1	5.15	5	5.1	5.2	V
ΔV_{REF}	Line Regulation	V_i = 8 to 35 V		10	20		10	20	mV
ΔV_{REF}	Load Regulation	I_L = 0 to 20 mA		20	50		20	50	mV
$\Delta V_{REF}/\Delta T$*	Temp. Stability	Over Operating Range		20	50		20	50	mV
*	Total Output Variation	Line, Load and Temperature	5		5.2	4.95		5.25	V
	Short Circuit Current	V_{REF} = 0 T_j = 25 °C		80	100		80	100	mA
*	Output Noise Voltage	10 Hz ≤f ≤ 10 kHz, T_j = 25 °C		40	200		40	200	µVrms
ΔV_{REF}*	Long Term Stability	T_j = 125 °C, 1000 hrs		20	50		20	50	mV
OSCILLATOR SECTION * *									
*, •	Initial Accuracy	T_j = 25 °C		± 2	± 6		± 2	± 6	%
*, •	Voltage Stability	V_i = 8 to 35 V		± 0.3	± 1		± 1	± 2	%
$\Delta f/\Delta T$*	Temperature Stability	Over Operating Range		± 3	± 6		± 3	± 6	%
f_{MIN}	Minimum Frequency	R_T = 200 KΩ C_T = 0.1 µF			120			120	Hz
f_{MAX}	Maximum Frequency	R_T = 2 KΩ C_T = 470 pF	400			400			KHz
	Current Mirror	I_{RT} = 2 mA	1.7	2	2.2	1.7	2	2.2	mA
*, •	Clock Amplitude		3	3.5		3	3.5		V
*, •	Clock Width	T_j = 25 °C	0.3	0.5	1	0.3	0.5	1	µs
	Sync Threshold		1.2	2	2.8	1.2	2	2.8	V
	Sync Input Current	Sync Voltage = 3.5 V		1	2.5		1	2.5	mA
ERROR AMPLIFIER SECTION (V_{CM} = 5.1 V)									
V_{OS}	Input Offset Voltage			0.5	5		2	10	mV
I_b	Input Bias Current			1	10		1	10	µA
I_{os}	Input Offset Current				1			1	µA
	DC Open Loop Gain	R_L ≥ 10 MΩ	60	75		60	75		dB
*	Gain Bandwidth Product	G_v = 0 dB T_j = 25 °C	1	2		1	2		MHz
*, ∎	DC Transconduct.	30 KΩ ≤ R_L ≤ 1 MΩ T_j = 25 °C	1.1	1.5		1.1	1.5		ms
	Output Low Level			0.2	0.5		0.2	0.5	V
	Output High Level		3.8	5.6		3.8	5.6		V
CMR	Comm. Mode Reject.	V_{CM} = 1.5 to 5.2 V	60	75		60	75		dB
PSR	Supply Voltage Rejection	V_i = 8 to 35 V	50	60		50	60		dB

ELECTRICAL CHARACTERISTICS (continued)

Symbol	Parameter	Test Conditions	SG2525A			SG3525A			Unit
			Min.	Typ.	Max.	Min.	Typ.	Max.	
PWM COMPARATOR									
	Minimum Duty-cycle				0			0	%
•	Maximum Duty-cycle		45	49		45	49		%
•	Input Threshold	Zero Duty-cycle	0.7	0.9		0.7	0.9		V
		Maximum Duty-cycle		3.3	3.6		3.3	3.6	V
*	Input Bias Current			0.05	1		0.05	1	µA
SHUTDOWN SECTION									
	Soft Start Current	V_{SD} = 0 V, V_{SS} = 0 V	25	50	80	25	50	80	µA
	Soft Start Low Level	V_{SD} = 2.5 V		0.4	0.7		0.4	0.7	V
	Shutdown Threshold	To outputs, V_{SS} = 5.1 V T_j = 25 °C	0.6	0.8	1	0.6	0.8	1	V
	Shutdown Input Current	V_{SD} = 2.5 V		0.4	1		0.4	1	mA
*	Shutdown Delay	V_{SD} = 2.5 V T_j = 25 °C		0.2	0.5		0.2	0.5	µs
OUTPUT DRIVERS (each output) (V_C = 20 V)									
	Output Low Level	I_{sink} = 20 mA		0.2	0.4		0.2	0.4	V
		I_{sink} = 100 mA		1	2		1	2	V
	Output High Level	I_{source} = 20 mA	18	19		18	19		V
		I_{source} = 100 mA	17	18		17	18		V
	Under-Voltage Lockout	V_{comp} and V_{ss} = High	6	7	8	6	7	8	V
I_C	Collector Leakage	V_C = 35 V			200			200	µA
t_r*	Rise Time	C_L = 1 nF, T_j = 25 °C		100	600		100	600	ns
t_f*	Fall Time	C_L = 1 nF, T_j = 25 °C		50	300		50	300	ns
TOTAL STANDBY CURRENT									
I_S	Supply Current	V_i = 35 V		14	20		14	20	mA

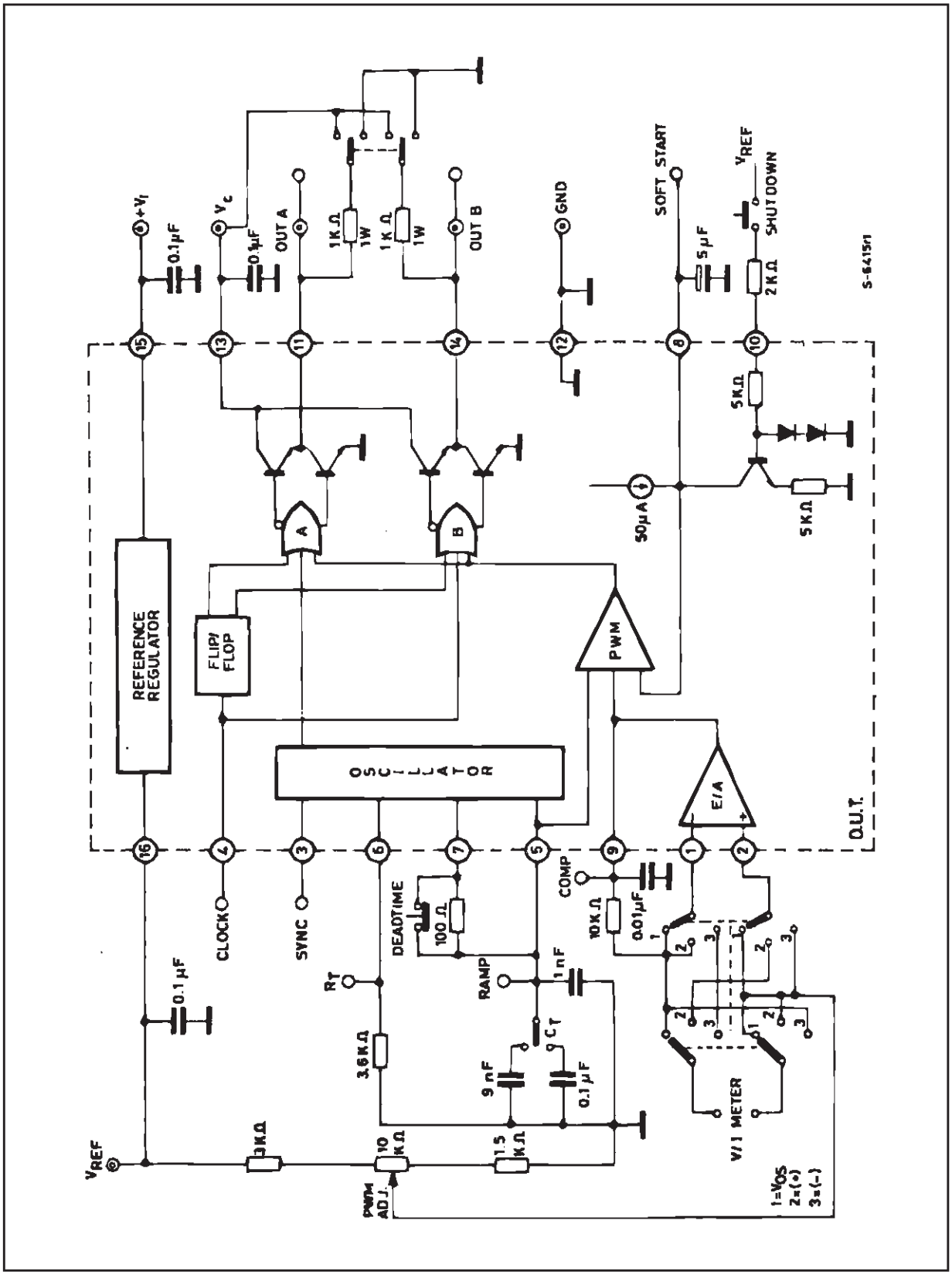
* These parameters, although guaranteed over the recommended operating conditions, are not 100 % tested in production.

• Tested at f_{osc} = 40 KHz (R_T = 3.6 KΩ, C_T = 10nF, R_D = 0 Ω). Approximate oscillator frequency is defined by :

$$f = \frac{1}{C_T(0.7\,R_T + 3\,R_D)}$$

■ DC transconductance (g_M) relates to DC open-loop voltage gain (G_v) according to the following equation : $G_v = g_M\,R_L$ where R_L is the resistance from pin 9 to ground. The minimum g_M specification is used to calculate minimum G_v when the error amplifier output is loaded.

TEST CIRCUIT



RECOMMENDED OPERATING CONDITIONS (•)

Parameter	Value
Input Voltage (V_i)	8 to 35 V
Collector Supply Voltage (V_C)	4.5 to 35 V
Sink/Source Load Current (steady state)	0 to 100 mA
Sink/Source Load Current (peak)	0 to 400 mA
Reference Load Current	0 to 20 mA
Oscillator Frequency Range	100 Hz to 400 KHz
Oscillator Timing Resistor	2 KΩ to 150 KΩ
Oscillator Timing Capacitor	0.001 μF to 0.1 μF
Dead Time Resistor Range	0 to 500 Ω

(•) Range over which the device is functional and parameter limits are guaranteed.

Figure 1 : Oscillator Charge Time vs. R_T and C_T.

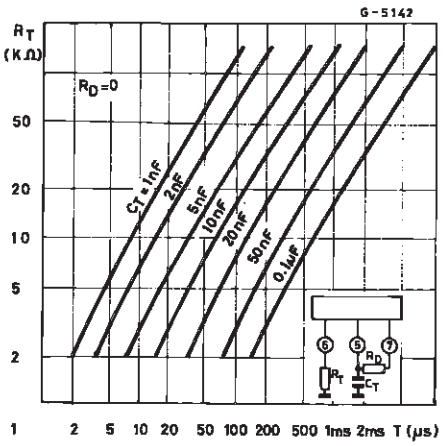


Figure 2 : Oscillator Discharge Time vs. R_D and C_T.

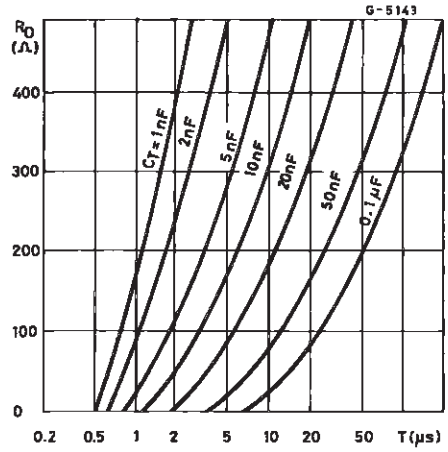


Figure 3 : Output Saturation Characteristics.

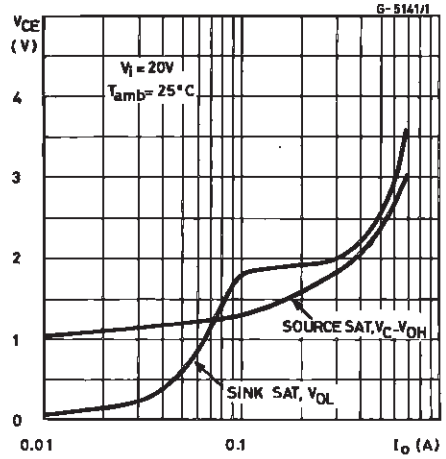


Figure 4 : Error Amplifier Voltage Gain and Phase vs. Frequency.

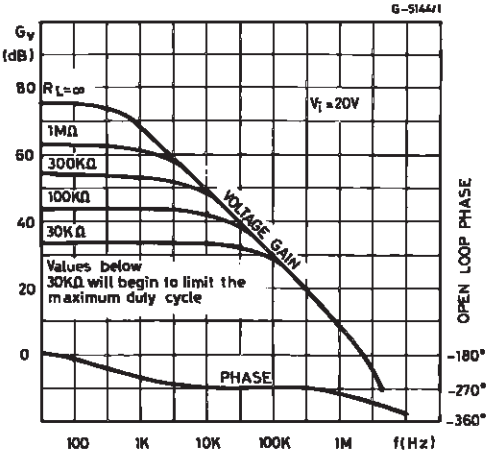
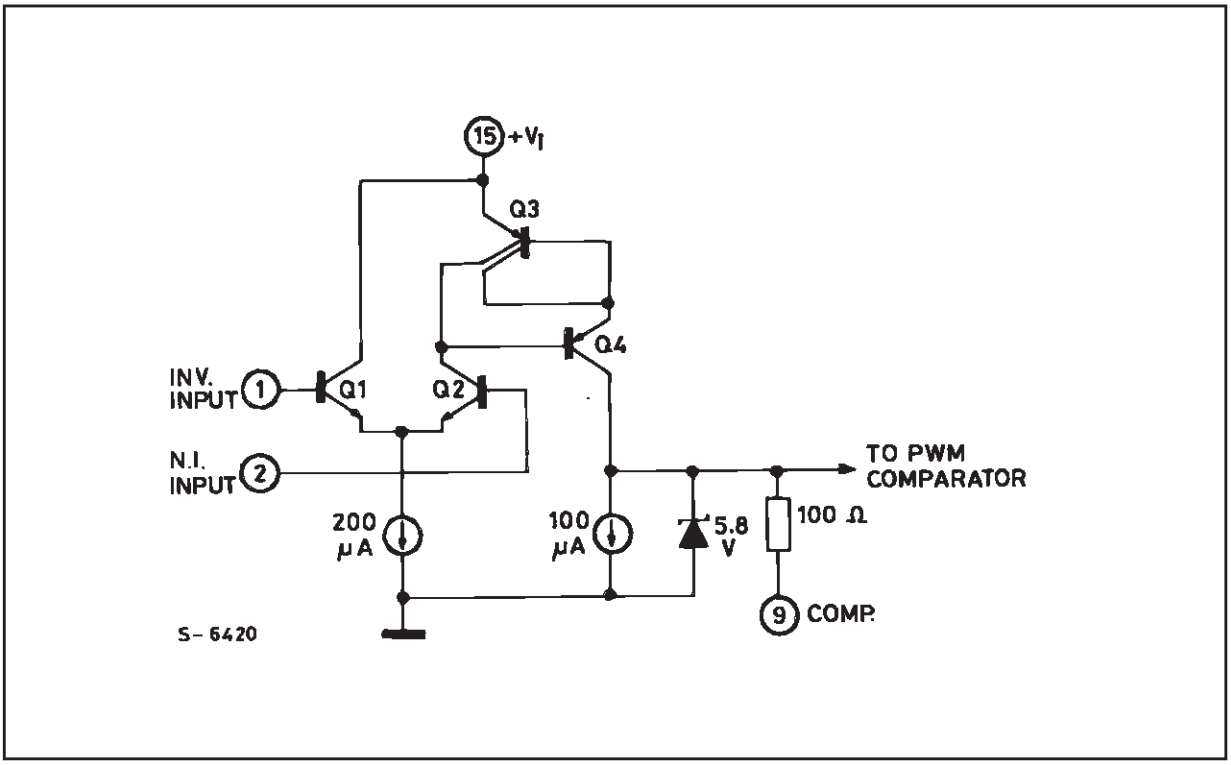


Figure 5 : Error Amplifier.



PRINCIPLES OF OPERATION

SHUTDOWN OPTIONS (see Block Diagram)

Since both the compensation and soft-start terminals (Pins 9 and 8) have current source pull-ups, either can readily accept a pull-down signal which only has to sink a maximum of 100 µA to turn off the outputs. This is subject to the added requirement of discharging whatever external capacitance may be attached to these pins.

An alternate approach is the use of the shutdown circuitry of Pin 10 which has been improved to enhance the available shutdown options. Activating this circuit by applying a positive signal on Pin 10 performs two functions : the PWM latch is immediately set providing the fastest turn-off signal to the outputs ; and a 150 µA current sink begins to discharge the external soft-start capacitor. If the shutdown command is short, the PWM signal is terminated without significant discharge of the soft-start capacitor, thus, allowing, for example, a convenient implementation of pulse-by-pulse current limiting. Holding Pin 10 high for a longer duration, however, will ultimately discharge this external capacitor, recycling slow turn-on upon release.

Pin 10 should not be left floating as noise pickup could conceivably interrupt normal operation.

Figure 6 : Oscillator Schematic.

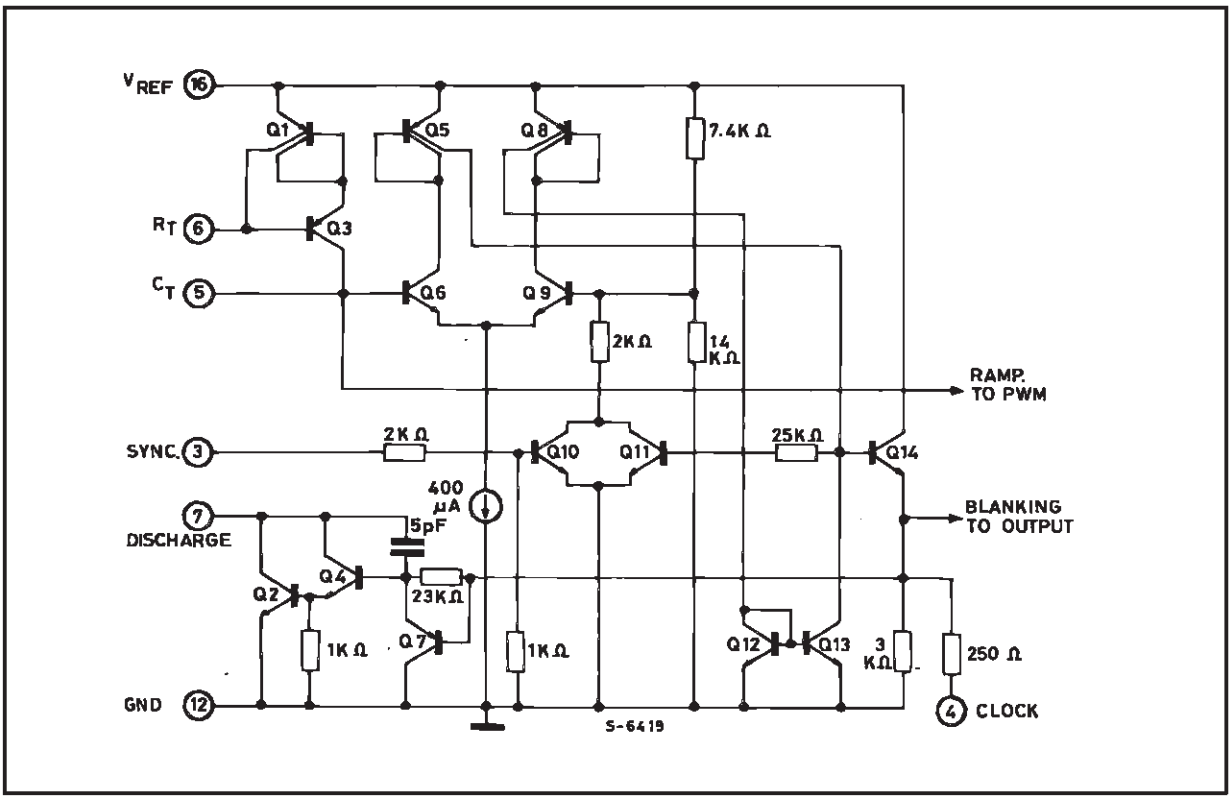


Figure 7 : Output Circuit (1/2 circuit shown).

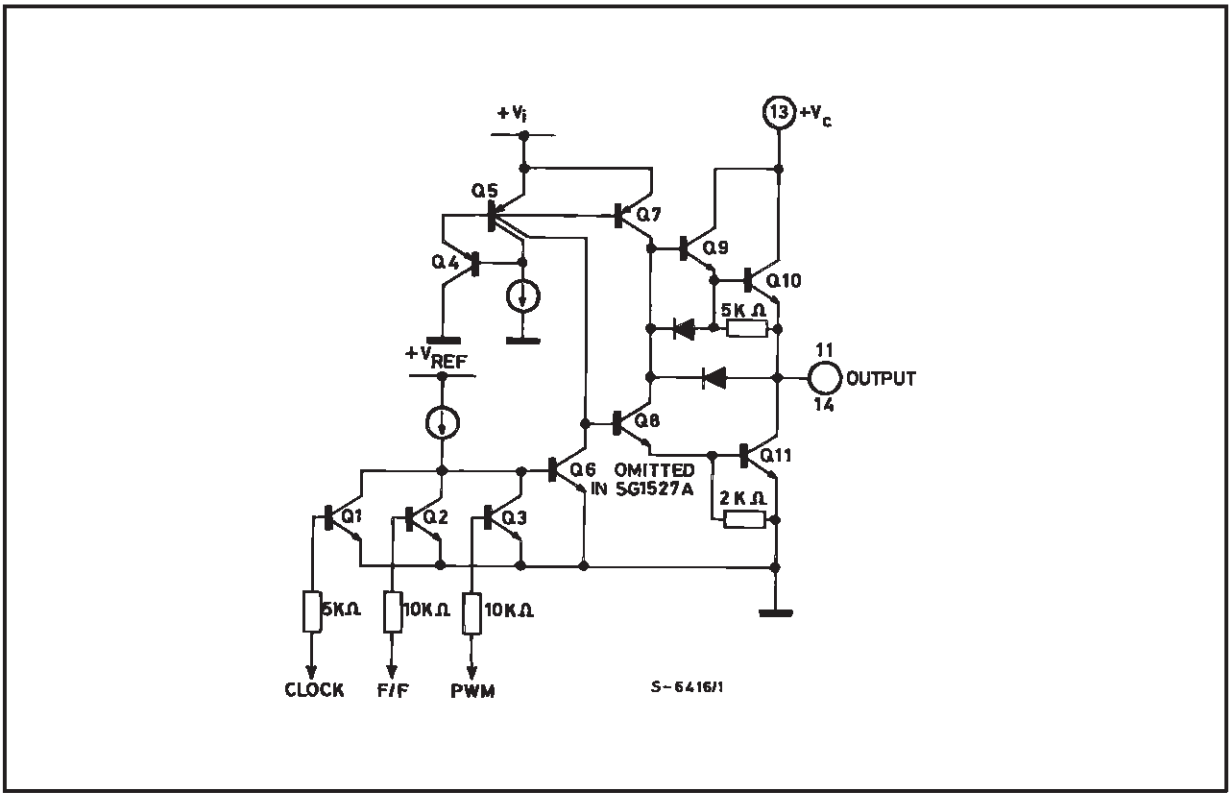
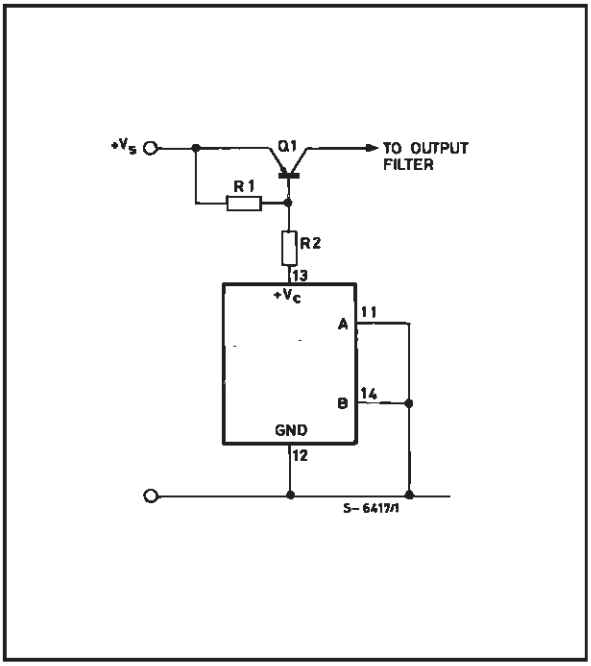
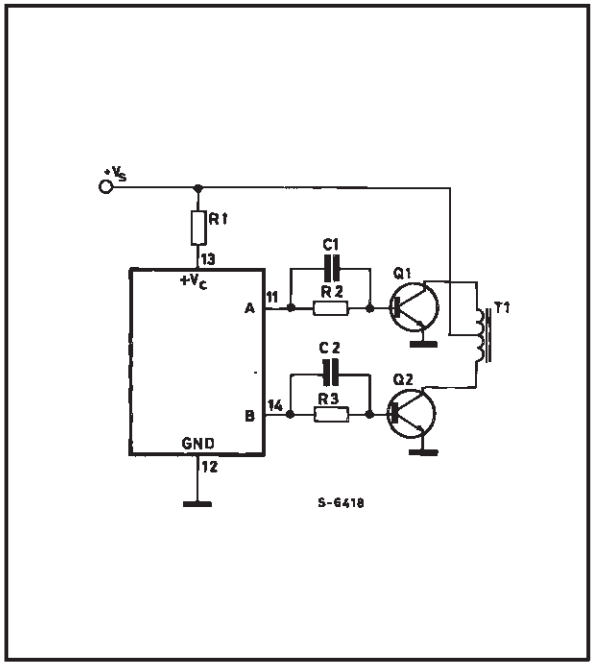


Figure 8.



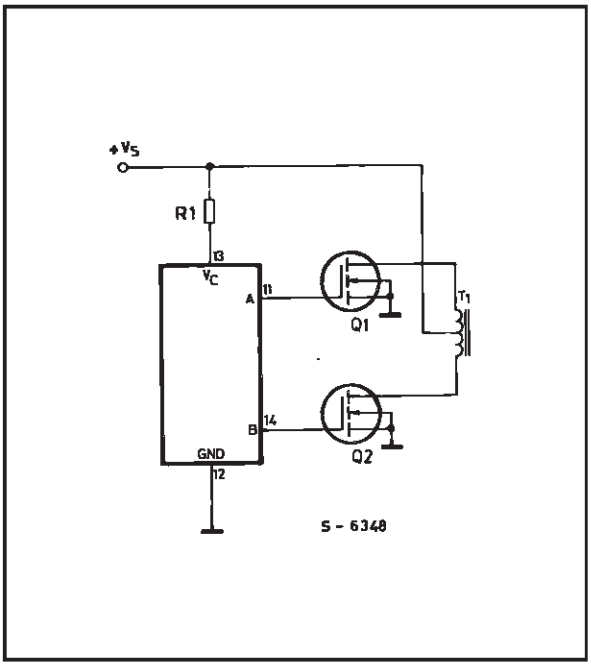
For single-ended supplies, the driver outputs are grounded. The V_C terminal is switched to ground by the totem-pole source transistors on alternate oscillator cycles.

Figure 9.



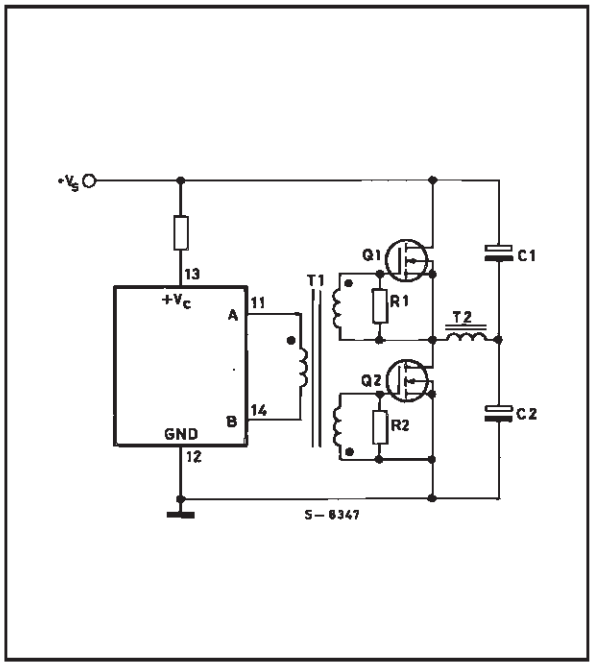
In conventional push-pull bipolar designs, forward base drive is controlled by R_1 - R_3. Rapid turn-off times for the power devices are achieved with speed-up capacitors C_1 and C_2.

Figure 10.



The low source impedance of the output drivers provides rapid charging of Power Mos input capacitance while minimizing external components.

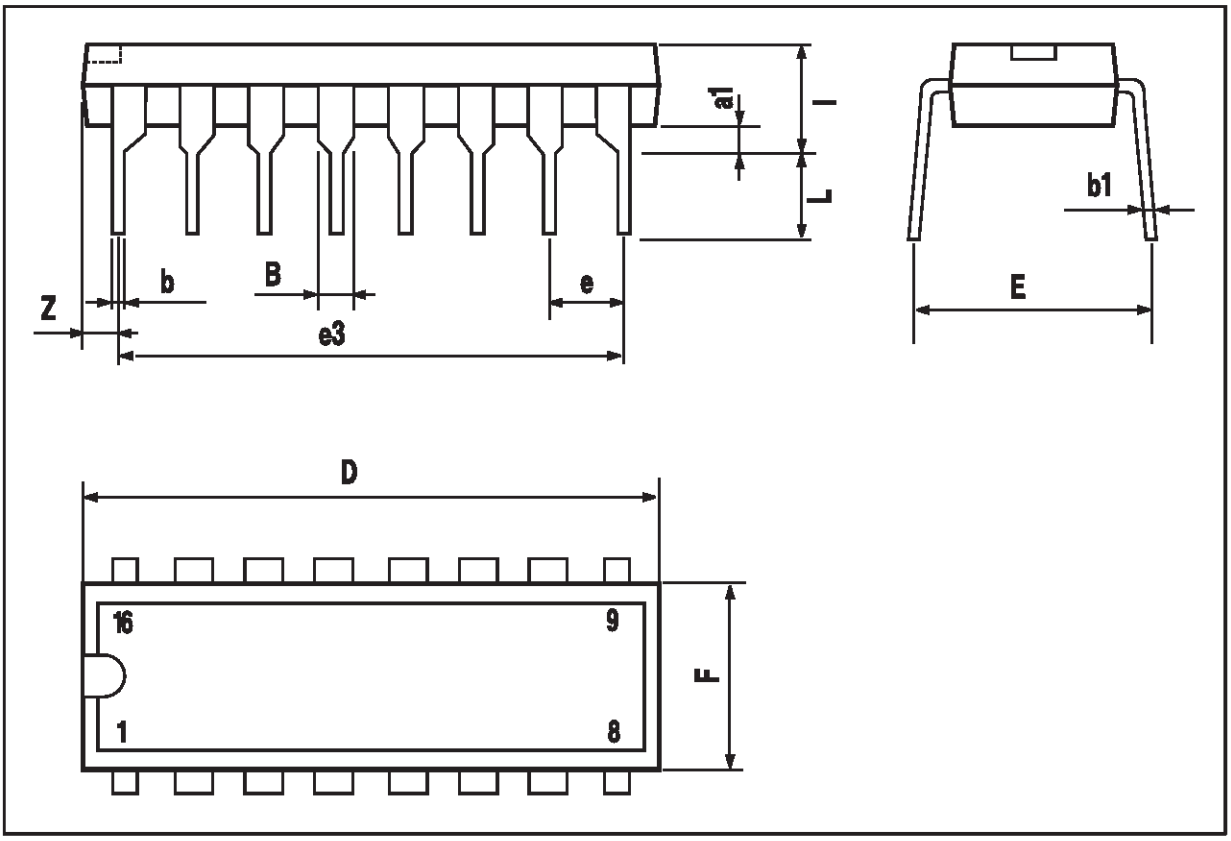
Figure 11.



Low power transformers can be driven directly. Automatic reset occurs during dead time, when both ends of the primary winding are switched to ground.

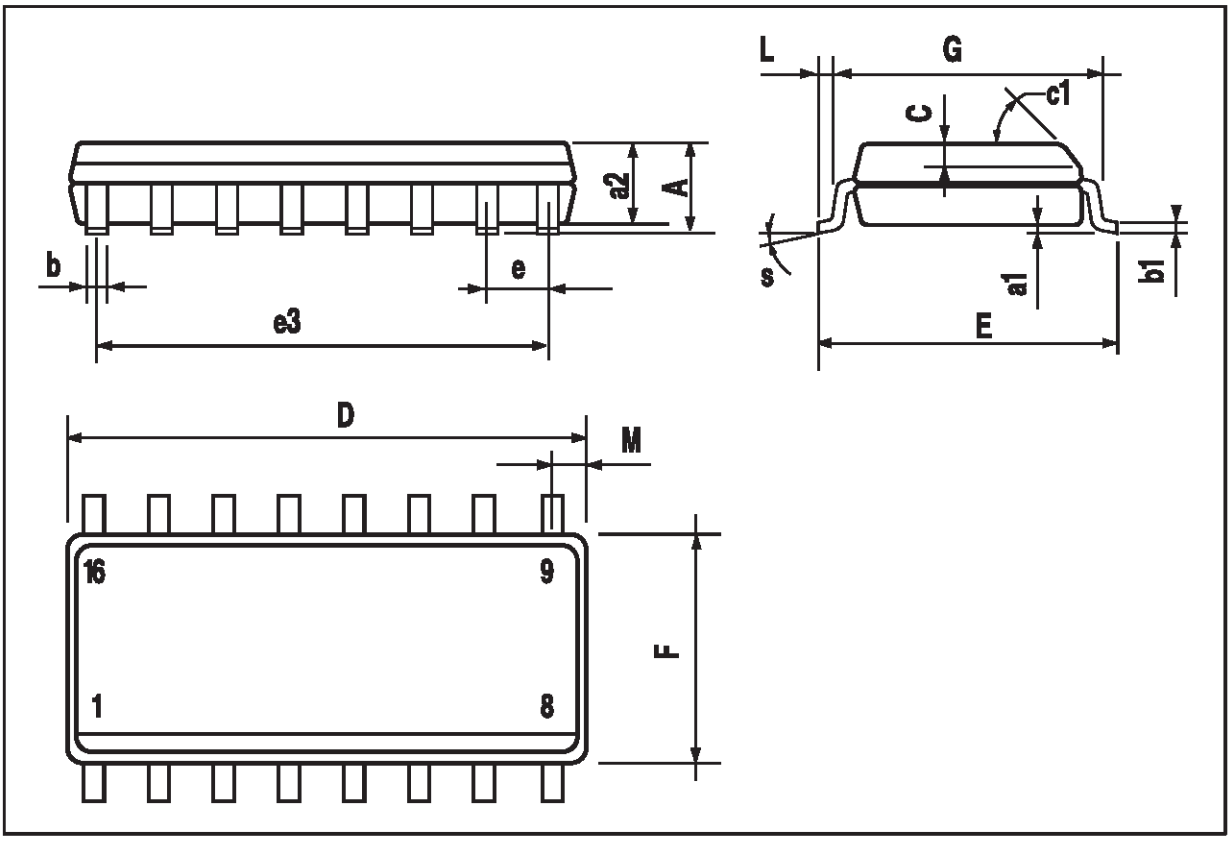
DIP16 PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
a1	0.51			0.020		
B	0.77		1.65	0.030		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		17.78			0.700	
F			7.1			0.280
I			5.1			0.201
L		3.3			0.130	
Z			1.27			0.050



SO16 NARROW PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			1.75			0.069
a1	0.1		0.25	0.004		0.009
a2			1.6			0.063
b	0.35		0.46	0.014		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.020	
c1	45° (typ.)					
D	9.8		10	0.386		0.394
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		8.89			0.350	
F	3.8		4.0	0.150		0.157
L	0.4		1.27	0.150		0.050
M			0.62			0.024
S	8° (max.)					



19-0239; Rev 0; 7/94

MAXIM

50mA, Frequency-Selectable, Switched-Capacitor Voltage Converters

General Description

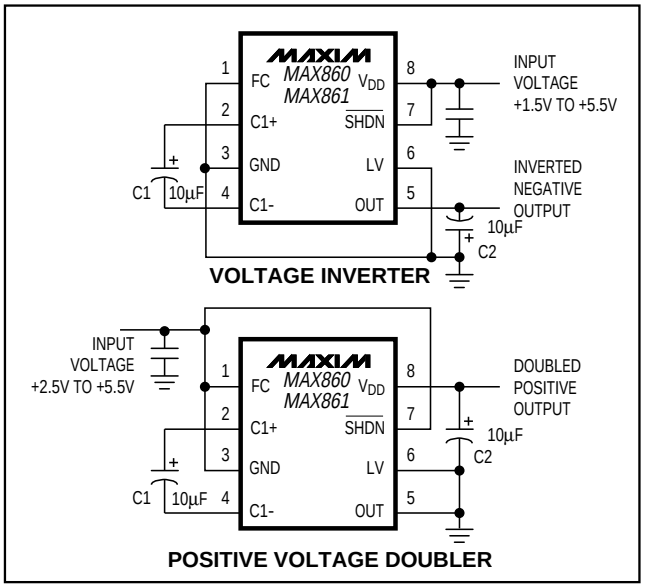
The MAX860/MAX861 charge-pump voltage converters invert input voltages ranging from 1.5V to 5.5V, or double input voltages ranging from 2.5V to 5.5V. Because of their high switching frequencies, these devices use only two small, low-cost capacitors. Their 50mA output makes switching regulators unnecessary, eliminating inductors and their associated cost, size, and EMI. Greater than 90% efficiency over most of the load-current range, combined with a typical operating current of only 200µA (MAX860), provides ideal performance for both battery-powered and board-level voltage-conversion applications.

A frequency-control (FC) pin provides three switching-frequencies to optimize capacitor size and quiescent current and to prevent interference with sensitive circuitry. Each device has a unique set of three available frequencies. A shutdown ($\overline{SHDN}$) pin reduces current consumption to less than 1µA. The MAX860/MAX861 are suitable for use in applications where the ICL7660 and MAX660's switching frequencies are too low. The MAX860/MAX861 are available in 8-pin µMAX and SO packages.

Applications

Portable Computers
Medical Instruments
Interface Power Supplies
Hand-Held Instruments
Operational-Amplifier Power Supplies

Typical Operating Circuit



Features

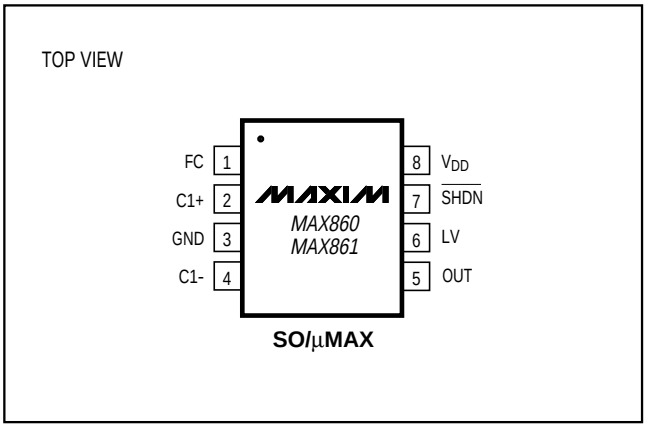
- ♦ **8-Pin, 1.11mm High µMAX Package**
- ♦ **Invert or Double the Input Supply Voltage**
- ♦ **Three Selectable Switching Frequencies**
- ♦ **High Frequency Reduces Capacitor Size**
- ♦ **87% Efficiency at 50mA**
- ♦ **200µA Quiescent Current (MAX860)**
- ♦ **1µA Shutdown Supply Current**
- ♦ **600mV Voltage Drop at 50mA Load**
- ♦ **12Ω Output Resistance**

Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX860CSA	0°C to +70°C	8 SO
MAX860CUA	0°C to +70°C	8 µMAX
MAX860C/D	0°C to +70°C	Dice*
MAX860ESA	-40°C to +85°C	8 SO
MAX860MJA	-55°C to +125°C	8 CERDIP†
MAX861CSA	0°C to +70°C	8 SO
MAX861CUA	0°C to +70°C	8 µMAX
MAX861C/D	0°C to +70°C	Dice*
MAX861ESA	-40°C to +85°C	8 SO
MAX861MJA	-55°C to +125°C	8 CERDIP†

** Dice are tested at T_A = +25°C, DC parameters only.*
† Contact factory for availability.

Pin Configuration



SO/µMAX

Call toll free 1-800-998-8800 for free samples or literature.

50mA, Frequency-Selectable, Switched-Capacitor Voltage Converters

ABSOLUTE MAXIMUM RATINGS

Supply Voltage (V_{DD} to GND or GND to OUT) 6.0V
Input Voltage Range (LV, FC, $\overline{SHDN}$) .....(OUT - 0.3V) to (V_{DD} + 0.3V)
Continuous Output Current (OUT, V_{DD}) 60mA
Output Short-Circuit to GND (Note 1).....1sec
Continuous Power Dissipation (T_A = +70°C)
SO (derate 5.88mW/°C above +70°C).....471mW
µMAX (derate 4.10mW/°C above +70°C) 330mW
CERDIP (derate 8.00mW/°C above +70°C).....640mW

Operating Temperature Ranges
MAX86_C_A.....0°C to +70°C
MAX86_ESA.....-40°C to +85°C
MAX86_MJA .....-55°C to +125°C
Storage Temperature Range .....-65°C to +160°C
Lead Temperature (soldering, 10sec) .....+300°C

Note 1: OUT may be shorted to GND for 1sec without damage, but shorting OUT to V_{DD} may damage the device and should be avoided. Also, for temperatures above +85°C, OUT must not be shorted to GND or V_{DD}, even instantaneously, or device damage may result.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(Typical Operating Circuit (Inverter), V_{DD} = +5V, $\overline{SHDN}$ = V_{DD}, FC = LV = GND, C1 = C2 = 10µF (Note 2), T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Supply Voltage	V_{DD}	R_L = 1kΩ	Inverter, LV = open	3.0		5.5	V
			Inverter, LV = GND	1.5		5.5	
			Doubler, LV = OUT	2.5		5.5	
No-Load Supply Current	I_{DD}	MAX860C/E	FC = V_{DD} = 5V		0.2	0.3	mA
			FC = V_{DD} = 3V		0.07		
			FC = GND		0.6	1.0	
			FC = OUT		1.4	2.5	
		MAX860M	FC = V_{DD}			0.4	
			FC = GND			1.3	
			FC = OUT			3.3	
		MAX861C/E	FC = V_{DD}		0.3	0.4	
			FC = GND		1.1	2.0	
			FC = OUT		2.5	5.0	
		MAX861M	FC = V_{DD}			0.5	
			FC = GND			2.6	
			FC = OUT			6.5	
Output Current	I_{OUT}	V_{DD} = 5V, V_{OUT} more negative than -3.75V		50	100		mA
		V_{DD} = 3V, V_{OUT} more negative than -2.5V		10	30		
Output Resistance (Note 3)	R_{OUT}	I_L = 50mA			12	25	Ω
		I_L = 10mA, V_{DD} = 2V			20	35	

ELECTRICAL CHARACTERISTICS (continued)

(Typical Operating Circuit (Inverter), V_{DD} = +5V, $\overline{SHDN}$ = V_{DD}, FC = LV = GND, C1 = C2 = 10µF (Note 2), T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Switching Frequency (Note 4)	f_S	MAX860	FC = V_{DD}	3	6		kHz
			FC = GND	30	50		
			FC = OUT	80	130		
		MAX861	FC = V_{DD}	8	13		
			FC = GND	60	100		
			FC = OUT	160	250		
FC Current (from V_{DD})	I_{FC}	FC < 4V			-2	-4	µA
Power Efficiency (Note 5)		MAX860, FC = V_{DD}	R_L = 2kΩ from V_{DD} to OUT	93	96		%
			R_L = 1kΩ from OUT to GND	90	93		
		MAX861, FC = V_{DD}	R_L = 2kΩ from V_{DD} to OUT	93	96		
			R_L = 1kΩ from OUT to GND	88	92		
		MAX860/MAX861, FC = V_{DD}, I_L = 50mA to GND, C1 = C2 = 68µF			87		
Voltage-Conversion Efficiency		No load		99	99.9		%
$\overline{SHDN}$ Threshold	V_{IH}	LV = open		2.5			V
		LV = GND		1.2			
	V_{IL}					0.3	
Shutdown Supply Current		$\overline{SHDN}$ < 0.3V	MAX86_C/E			1	µA
			MAX86_M			10	
Time to Exit Shutdown		No load, V_{OUT} = -4V			500		µs

Note 2: C1 and C2 are low-ESR (<0.2Ω) aluminum electrolytics. Capacitor ESR adds to the circuit's output resistance. Using capacitors with higher ESR may reduce output voltage and efficiency.

Note 3: Specified output resistance includes the effect of the 0.2Ω ESR of the test circuit's capacitors.

Note 4: The switches are driven directly at the oscillator frequency, without any division.

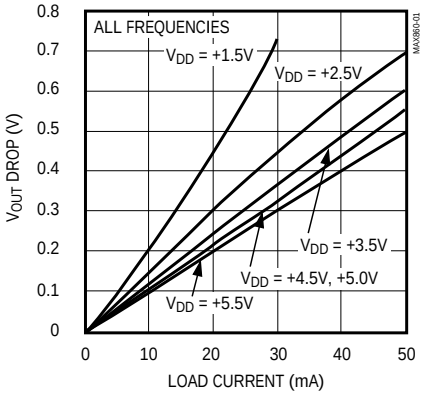
Note 5: At lowest frequencies, using 10µF capacitors gives worse efficiency figures than using the recommended capacitor values in Table 3, due to larger $1/(f_S \times C1)$ term in R_{OUT}.

50mA, Frequency-Selectable, Switched-Capacitor Voltage Converters

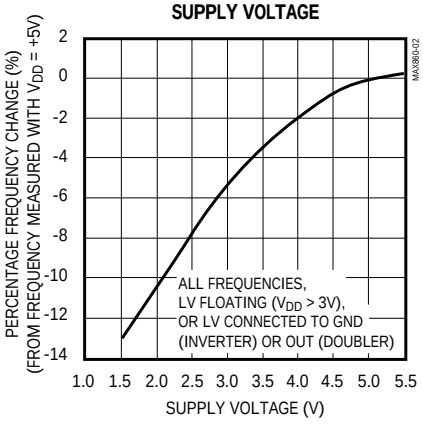
Typical Operating Characteristics

(All curves generated using the inverter circuit shown in the *Typical Operating Circuits* with LV = GND and T_A = +25°C, unless otherwise noted. Test results also valid for doubler mode with LV = OUT and T_A = +25°C, unless otherwise noted. All capacitor values used are those recommended in Table 3. All capacitors are low-ESR Sanyo OS-CONs. The output resistance curves represent the resistance of the device itself, which is R_O in the equation for R_{OUT} shown in the *Capacitor Selection* section.)

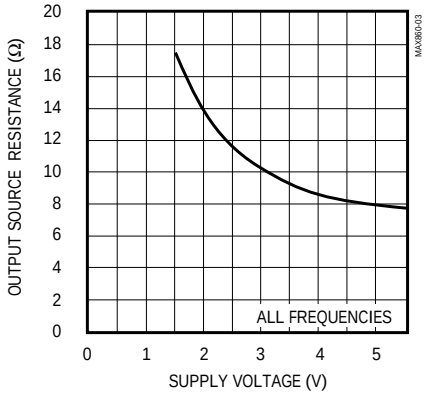
OUTPUT VOLTAGE DROP FROM SUPPLY VOLTAGE vs. LOAD CURRENT



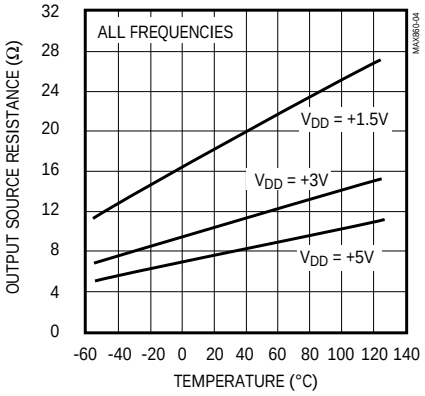
OSCILLATOR FREQUENCY vs. SUPPLY VOLTAGE



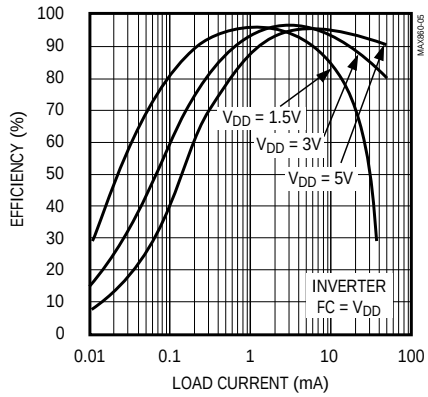
OUTPUT SOURCE RESISTANCE (R_O) vs. SUPPLY VOLTAGE



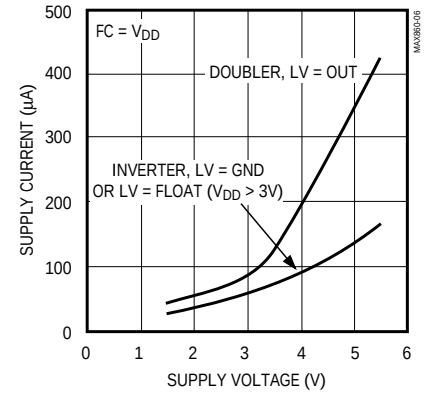
OUTPUT SOURCE RESISTANCE (R_O) vs. TEMPERATURE



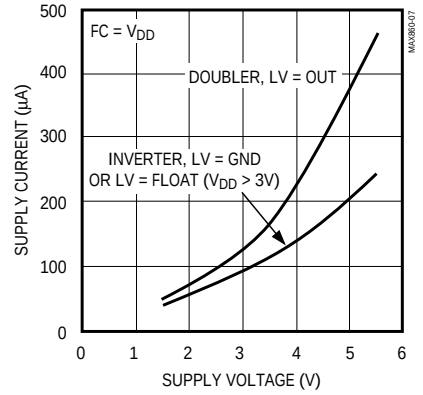
MAX860 EFFICIENCY vs. LOAD CURRENT



MAX860 SUPPLY CURRENT vs. SUPPLY VOLTAGE



MAX861 SUPPLY CURRENT vs. SUPPLY VOLTAGE



Pin Description

PIN	NAME	FUNCTION	
		INVERTER	DOUBLER
1	FC	Frequency Control, see Table 1	Frequency Control, see Table 1
2	C1+	Flying-Capacitor Positive Terminal	Flying-Capacitor Positive Terminal
3	GND	Ground	Positive Input Supply
4	C1-	Flying-Capacitor Negative Terminal	Flying-Capacitor Negative Terminal
5	OUT	Negative Output	Ground
6	LV	Low-Voltage-Operation Input. Connect to GND for V_{DD} < 3V. Connect to GND or leave floating for V_{DD} > 3V.	Low-Voltage-Operation Input. Connect to OUT.
7	$\overline{SHDN}$	Active-Low Shutdown Input. Connect to V_{DD} if not used. Connect to GND to disable the charge pump.	Active-Low Shutdown Input. Connect to GND pin if not used. Connect to OUT to disable the charge pump.
8	V_{DD}	Positive Input Supply	Doubled Positive Output

Detailed Description

The MAX860/MAX861 capacitive charge pumps either invert or double the voltage applied to their inputs. For highest performance, use low equivalent series resistance (ESR) capacitors. See the *Capacitor Selection* section for more details. The frequency-control (FC) pin allows you to choose one of three switching frequencies; these three selectable frequencies are different for each device. When shut down, MAX860/MAX861 current consumption reduces to less than 1µA.

Common Applications

Voltage Inverter

The most common application for these devices is a charge-pump voltage inverter (see *Typical Operating Circuits*). This application requires only two external components—capacitors C1 and C2—plus a bypass capacitor if necessary (see *Bypass Capacitor* section). Refer to the *Capacitor Selection* section for suggested capacitor types and values.

Even though the MAX860/MAX861's output is not actively regulated, it is fairly insensitive to load-current changes. A circuit output source resistance of 12Ω (calculated using the formula given in the *Capacitor Selection* section) means that, with a +5V input, the output voltage is -5V under no load and decreases to -4.4V with a 50mA load. The MAX860/MAX861 output source resistance (used to calculate the circuit output source resistance) vs. temperature and supply voltage are shown in the *Typical Operating Characteristics* graphs.

Calculate the output ripple voltage using the formula given in the *Capacitor Selection* section.

Positive Voltage Doubler

The MAX860/MAX861 can also operate as positive voltage doublers (see *Typical Operating Circuits*). This application requires only two external components, capacitors C1 and C2. The no-load output is twice the input voltage. The electrical specifications in the doubler mode are very similar to those of the inverter mode except for the Supply Voltage Range (see *Electrical Characteristics* table) and No-Load Supply Current (see graph in *Typical Operating Characteristics*). The circuit output source resistance and output ripple voltage are calculated using the formulas in the *Capacitor Selection* section.

Active-Low Shutdown Input

When driven low, the $\overline{SHDN}$ input shuts down the device. In inverter mode, connect $\overline{SHDN}$ to V_{DD} if it is not used. In doubler mode, connect $\overline{SHDN}$ to GND if it is not used. When the device is shut down, all active circuitry is turned off.

In the inverting configuration, loads connected from OUT to GND are not powered in shutdown mode. However, a reverse-current path exists through two diodes between OUT and GND; therefore, loads connected from V_{DD} to OUT draw current from the input supply.

50mA, Frequency-Selectable, Switched-Capacitor Voltage Converters

In the doubling configuration, loads connected from the V_{DD} pin to the GND pin are not powered in shutdown mode. Loads connected from the V_{DD} pin to the OUT pin draw current from the input supply through a path similar to that of the inverting configuration (described above).

Frequency Control

Charge-pump frequency for both devices can be set to one of three values. Each device has a unique set of three available frequencies, as indicated in Table 1. The oscillator and charge-pump frequencies are the same (i.e., the charge-pump frequency is not half the oscillator frequency, as it is on the MAX660, MAX665, and ICL7660).

Table 1. Nominal Switching Frequencies*

FC CONNECTION	FREQUENCY (kHz)	
	MAX860	MAX861
FC = V_{DD} or open	6	13
FC = GND	50	100
FC = OUT	130	250

**See the Electrical Characteristics for detailed switching-frequency specifications.*

A higher switching frequency minimizes capacitor size for the same performance and increases the supply current (Table 2). The lowest fundamental frequency of the switching noise is equal to the minimum specified switching frequency (e.g., 3kHz for the MAX860 with FC open). The spectrum of noise frequencies extends above this value because of harmonics in the switching waveform. To get best noise performance, choose the device and FC connection to select a minimum switching frequency that lies above your sensitive bandwidth.

Low-Voltage-Operation Input

LV should normally be connected to GND for inverting operation. To enhance compatibility with the MAX660, MAX665, and ICL7660, you may float LV if the input voltage exceeds 3V. In doubling mode, LV must be connected to OUT for all input voltages.

Table 2. Switching-Frequency Trade-Offs

ATTRIBUTE	LOWER FREQUENCY	HIGHER FREQUENCY
Output Ripple	Larger	Smaller
C1, C2 Values	Larger	Smaller
Supply Current	Smaller	Larger

Applications Information

Capacitor Selection

The MAX860/MAX861 are tested using 10µF capacitors for both C1 and C2, although smaller or larger values can be used (Table 3). Smaller C1 values increase the output resistance; larger values reduce the output resistance. Above a certain point, increasing the capacitance of C1 has a negligible effect (because the output resistance becomes dominated by the internal switch resistance and the capacitor ESR). Low-ESR capacitors provide the lowest output resistance and ripple voltage. The output resistance of the entire circuit (inverter or doubler) is approximately:

$$R_{OUT} = R_O + 4 \times ESR_{C1} + ESR_{C2} + 1 / (f_S \times C1)$$

where R_O (the effective resistance of the MAX860/MAX861's internal switches) is approximately 8Ω and f_S is the switching frequency. R_{OUT} is typically 12Ω when using capacitors with 0.2Ω ESR and f_S, C1, and C2 values suggested in Table 3. When C1 and C2 are so large (or the switching frequency is so high) that the internal switch resistance dominates the output resistance, estimate the output resistance as follows:

$$R_{OUT} = R_O + 4 \times ESR_{C1} + ESR_{C2}$$

A typical design procedure is as follows:

1) Choose C1 and C2 to be the same, for convenience.
2) Select f_S:
   a) If you want to avoid a specific noise frequency, choose f_S appropriately.
   b) If you want to minimize capacitor cost and size, choose a high f_S.
   c) If you want to minimize current consumption, choose a low f_S.
3) Choose a capacitor based on Table 3, although higher or lower values can be used to optimize performance. Table 4 lists manufacturers who provide low-ESR capacitors.

Table 3. Suggested Capacitor Values

NOMINAL FREQUENCY (kHz)	C1, C2 (µF)
6	68
13	47
50	10
100	4.7
130	4.7
250	2.2

Table 4. Low-ESR Capacitor Manufacturers

MANUFACTURER	PHONE	FAX	DEVICE TYPE
AVX	(207) 282-5111 (800) 282-4975	(207) 283-1941	Surface mount, TPS series
Matsuo	(714) 969-2491	(714) 960-6492	Surface mount, 267 series
Nichicon	USA: (708) 843-7500 Japan: 81-7-5231-8461	USA: (708) 843-2798 Japan: 81-7-5256-4158	Through-hole, PL series
Sanyo	USA: (619) 661-6835 Japan: 81-7-2070-6306	USA: (619) 661-1055 Japan: 81-7-2070-1174	Through-hole, OS-CON series
Sprague	(603) 224-1961	(603) 224-1430	Surface mount, 595D series
United Chemi-Con	(714) 255-9500	(714) 255-9400	Through-hole, LXF series

0*Flying Capacitor, C1*

Increasing the size of the flying capacitor reduces the output resistance.

Output Capacitor, C2

Increasing the size of the output capacitor reduces the output ripple voltage. Decreasing its ESR reduces both output resistance and ripple. Smaller capacitance values can be used if one of the higher switching frequencies is selected, if less than the maximum rated output current (50mA) is required, or if higher ripple can be tolerated. The following equation for peak-to-peak ripple applies to both the inverter and doubler circuits.

$$V_{RIPPLE} = \frac{I_{OUT}}{2 \times f_S \times C2} + 2 \times I_{OUT} \times ESR_{C2}$$

Bypass Capacitor

Bypass the incoming supply to reduce its AC impedance and the impact of the MAX860/MAX861's switching noise. The recommended bypassing depends on the circuit configuration and where the load is connected.

When the inverter is loaded from OUT to GND or the doubler is loaded from V_{DD} to GND, current from the supply switches between 2 x I_{OUT} and zero. Therefore, use a large bypass capacitor (e.g., equal to the value of C1) if the supply has a high AC impedance.

When the inverter and doubler are loaded from V_{DD} to OUT, the circuit draws 2 x I_{OUT} constantly, except for short switching spikes. A 0.1µF bypass capacitor is sufficient.

Cascading Devices

Two devices can be cascaded to produce an even larger negative voltage, as shown in Figure 1. The unloaded output voltage is nominally -2 x V_{IN}, but this is reduced slightly by the output resistance of the first device multiplied by the quiescent current of the second. The output resistance of the complete circuit is approximately *five times* the output resistance of a single MAX860/MAX861.

Three or more devices can be cascaded in this way, but output resistance rises dramatically, and a better solution is offered by inductive switching regulators (such as the MAX755, MAX759, MAX764, or MAX774). Connect LV as with a standard inverter circuit (see *Pin Description*).

Paralleling Devices

Paralleling multiple MAX860s or MAX861s reduces the output resistance. As illustrated in Figure 2, each device requires its own pump capacitor (C1), but the reservoir capacitor (C2) serves all devices. C2's value should be increased by a factor of n, where n is the number of devices. Figure 2 shows the equation for calculating output resistance. An alternative solution is to use the MAX660 or MAX665, which are capable of supplying up to 100mA of load current. Connect LV as with a standard inverter circuit (see *Pin Description*).

Combined Doubler/Inverter

In the circuit of Figure 3, capacitors C1 and C2 form the inverter, while C3 and C4 form the doubler. C1 and C3 are the pump capacitors; C2 and C4 are the reservoir capacitors. Because both the inverter and doubler use part of the charge-pump circuit, loading either output causes both outputs to decline towards GND. Make sure the sum of the currents drawn from the two outputs does not exceed 60mA. Connect LV as with a standard inverter circuit (see *Pin Description*).

50mA, Frequency-Selectable, Switched-Capacitor Voltage Converters

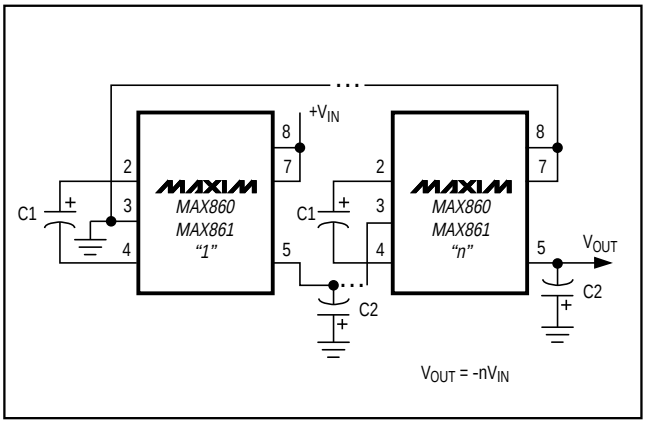


Figure 1. Cascading MAX860s or MAX861s to Increase Output Voltage

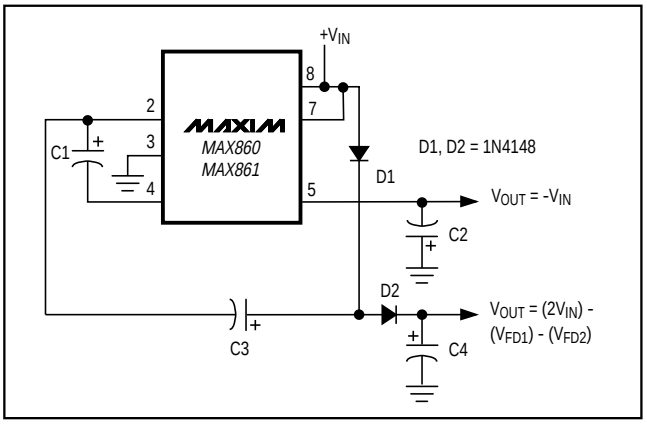


Figure 3. Combined Doubler and Inverter

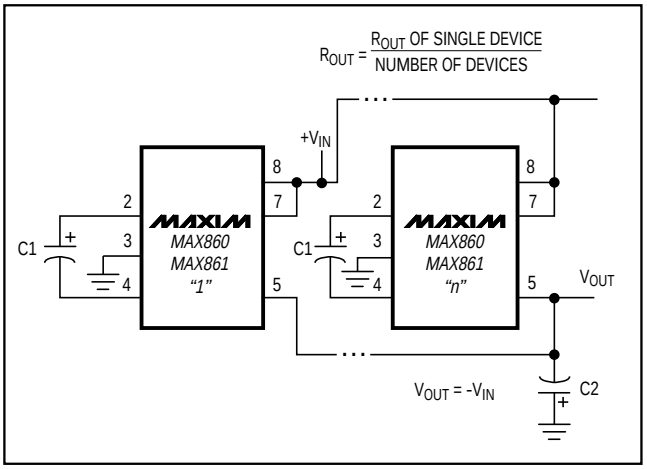


Figure 2. Paralleling MAX860s or MAX861s to Reduce Output Resistance

Table 5. Product Selection Guide

PART NUMBER	OUTPUT CURRENT (mA)	OUTPUT RESISTANCE (Ω)	SWITCHING FREQUENCY (kHz)
MAX660	100	6.5	5/40
MAX665	100	6.5	5/40
MAX860	50	12	6/50/130
MAX861	50	12	13/100/250
ICL7660	10	55	5

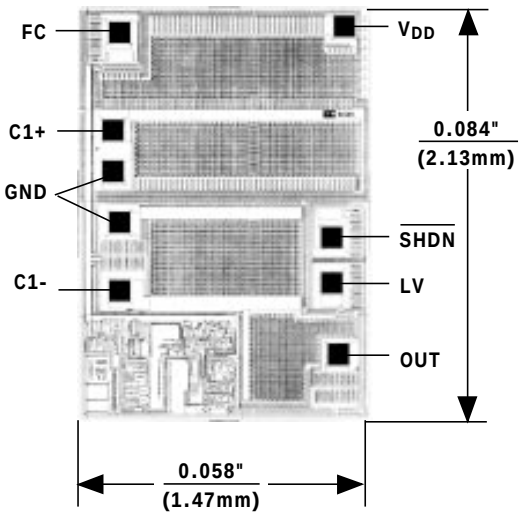
Compatibility with MAX660/MAX665/ICL7660

The MAX860/MAX861 can be used in sockets designed for the MAX660, MAX665, and ICL7660 with a minimum of one wiring change. This section gives advice on installing a MAX860/MAX861 into a socket designed for one of the earlier devices.

The MAX660, MAX665, and ICL7660 have an OSC pin instead of $\overline{SHDN}$. MAX660, MAX665, and ICL7660 normal operation is with OSC floating (although OSC can be overdriven). If OSC is floating, pin 7 ($\overline{SHDN}$) should be jumpered to V_{DD} to enable the MAX860/MAX861 permanently. Do not leave $\overline{SHDN}$ on the MAX860/MAX861 floating.

The MAX860/MAX861 operate with FC either floating or connected to V_{DD}, OUT, or GND; each connection defines the oscillator frequency. Thus, any of the normal MAX660, MAX665, or ICL7660 connections to pin 1 will work with the MAX860/MAX861, without modifications. Changes to the FC connection are only required if you want to adjust the operating frequency.

Chip Topography

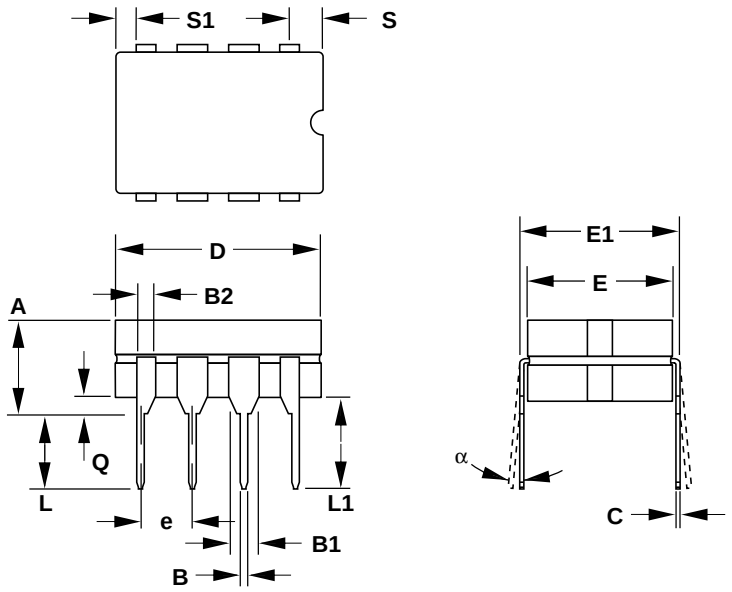


TRANSISTOR COUNT: 101

SUBSTRATE CONNECTED TO V_{DD}

50mA, Frequency-Selectable, Switched-Capacitor Voltage Converters

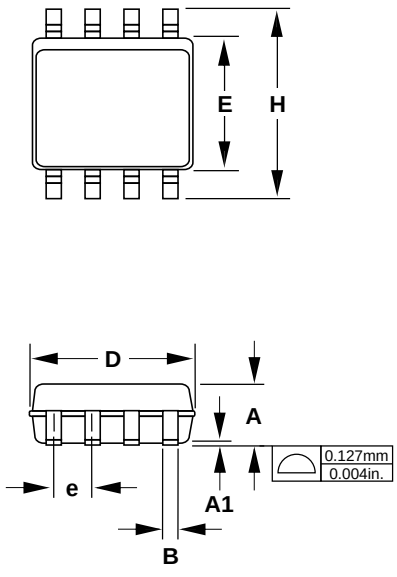
Package Information



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	–	0.200	–	5.08
B	0.014	0.023	0.36	0.58
B1	0.038	0.065	0.97	1.65
B2	0.023	0.045	0.58	1.14
C	0.008	0.015	0.20	0.38
D	–	0.405	–	10.29
E	0.220	0.310	5.59	7.87
E1	0.290	0.320	7.37	8.13
e	0.100 BSC		2.54 BSC	
L	0.125	0.200	3.18	5.08
L1	0.150	–	3.81	–
Q	0.015	0.060	0.38	1.52
S	–	0.055	–	1.40
S1	0.005	–	0.13	–
α	0°	15°	0°	15°

21-326D

8-PIN CERAMIC DUAL-IN-LINE PACKAGE

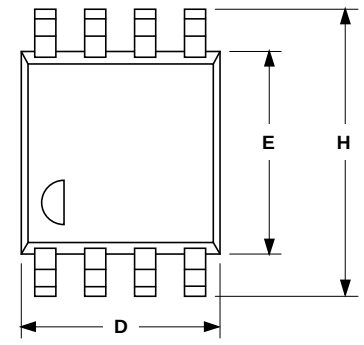


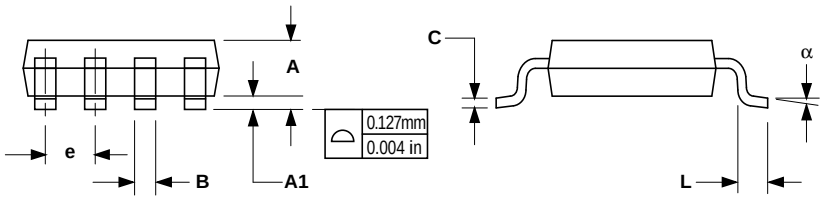
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.053	0.069	1.35	1.75
A1	0.004	0.010	0.10	0.25
B	0.014	0.019	0.35	0.49
C	0.007	0.010	0.19	0.25
D	0.189	0.197	4.80	5.00
E	0.150	0.157	3.80	4.00
e	0.050 BSC		1.27 BSC	
H	0.228	0.244	5.80	6.20
h	0.010	0.020	0.25	0.50
L	0.016	0.050	0.40	1.27
α	0°	8°	0°	8°

21-325A

8-PIN PLASTIC SMALL-OUTLINE PACKAGE

Package Information (continued)





DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.036	0.044	0.91	1.11
A1	0.004	0.008	0.10	0.20
B	0.010	0.014	0.25	0.36
C	0.005	0.007	0.13	0.18
D	0.116	0.120	2.95	3.05
E	0.116	0.120	2.95	3.05
e	0.0256		0.65	
H	0.188	0.198	4.78	5.03
L	0.016	0.026	0.41	0.66
α	0°	6°	0°	6°

21-0036

8-PIN μMAX PACKAGE

50mA, Frequency-Selectable, Switched-Capacitor Voltage Converters

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19-1095; Rev 1; 10/96

MAXIM

1-Cell to 3-Cell, High-Power, Low-Noise, Step-Up DC-DC Converters

General Description

The MAX848/MAX849 boost converters set a new standard of high efficiency and high integration for noise-sensitive power-supply applications, such as portable phones and small systems with RF data links. The heart of the these devices is a synchronous boost-topology regulator that generates a fixed 3.3V output (or 2.7V to 5.5V adjustable output) from one to three NiCd/NiMH cells or one Li-Ion cell.

Synchronous rectification provides a 5% efficiency improvement over similar nonsynchronous boost regulators. In standby mode, pulse-skipping PFM operation keeps the output voltage alive with only 150µW quiescent power consumption. Fixed-frequency PWM operation ensures that the switching noise spectrum is limited to the 300kHz fundamental and its harmonics, allowing easy post-filtering noise reduction. For even tighter noise spectrum control, synchronize to a 200kHz to 400kHz external clock.

Battery monitoring is provided by a two-channel, voltage-to-frequency analog-to-digital converter (ADC). One channel is intended for a single-cell battery input (0.625V to 1.875V range), while the other channel is for monitoring higher voltages (0V to 2.5V range).

Two control inputs are provided for push-on, push-off control via a momentary pushbutton switch. Upon power-up, an internal comparator monitors the output voltage to generate a power-good output (POK).

The devices differ only in the current limit of the N-channel MOSFET power switch: 0.8A for the MAX848, and 1.4A for the MAX849.

Features

- **Up to 95% Efficiency (see *Typical Output Selector Guide* below)**
- **3.3V Dual Mode™ or 2.7V to 5.5V Adj. Output**
- **0.7V to 5.5V Input Range**
- **0.15mW Standby Mode**
- **300kHz PWM Mode or Synchronizable**
- **Two-Channel ADC with Serial Output**
- **Power-Good Function**

Applications

Digital Cordless Phones	PCS Phones
Cellular Phones	Hand-Held Instruments
Palmtop Computers	Personal Communicators
Local 3.3V to 5V Supplies	

Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX848ESE	-40°C to +85°C	16 Narrow SO
MAX849ESE	-40°C to +85°C	16 Narrow SO

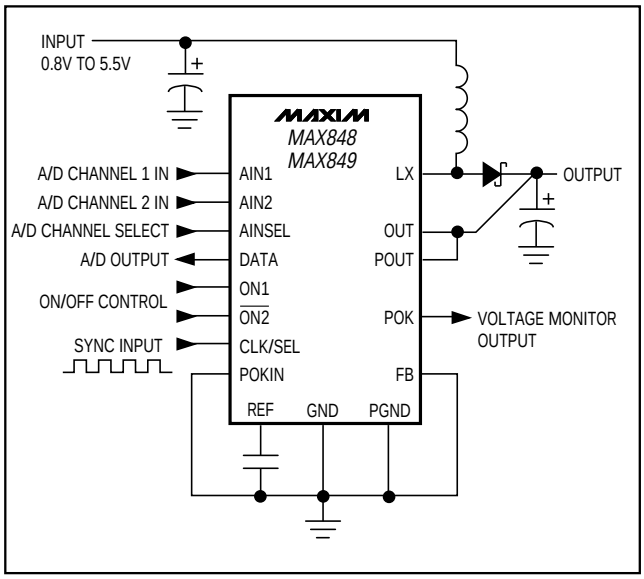
Typical Output Selector Guide

V_{IN} (V)	V_{OUT} (V)	MAX849 I_{OUT} (mA)	MAX848 I_{OUT} (mA)
0.9	3.3	100	70
	5	70	40
1.2	3.3	300	110
	5	200	70
2.4	3.3	750	200
	5	500	130
2.7	3.3	800	250
	5	600	150
3.6	5	1000	300

Pin Configuration at end of data sheet.

Dual Mode is a trademark of Maxim Integrated Products.

Typical Operating Circuit



For free samples & the latest literature: http://www.maxim-ic.com, or phone 1-800-998-8800

1-Cell to 3-Cell, High-Power, Low-Noise, Step-Up DC-DC Converters

ABSOLUTE MAXIMUM RATINGS

ON1, $\overline{ON2}$, OUT, POUT to GND .....-0.3V, +6V
PGND to GND .....-0.3V, +0.3V
LX to PGND .....-0.3V, (V_{POUT} + 0.3V)
CLK/SEL, DATA, POKIN, REF,
AINSEL, AIN1, AIN2, FB, POK to GND .....-0.3V, (V_{OUT} + 0.3V)
Continuous Power Dissipation (T_A = +70°C)
Narrow SO (derate 8.7mW/°C above +70°C) 696mW
Operating Temperature Range
MAX848ESE/MAX849ESE .....-40°C to +85°C
Junction Temperature.....+150°C
Storage Temperature.....-65°C to +160°C
Lead Temperature (soldering, 10sec) .....+300°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V_{OUT} = 3.6V, GND = PGND = CLK/SEL = ON1 = $\overline{ON2}$ = AINSEL = AIN1 = AIN2 = FB = POKIN, POUT = OUT, **T_A = 0°C to +85°C**, unless otherwise noted.)

PARAMETER	CONDITIONS			MIN	TYP	MAX	UNITS
Minimum Operating Voltage (Note 1)					0.7		V
REFERENCE							
Reference Output Voltage	I_{REF} = 0mA			1.23	1.25	1.27	V
REF Load Regulation	-1µA < I_{REF} < 50µA				5	15	mV
REF Supply Rejection	2.5V < V_{OUT} < 5V				0.2	5	mV
DC-DC CONVERTER							
Output Voltage (Note 2)	V_{FB} < 0.1V, CLK/SEL = OUT			3.17	3.34	3.40	V
Output Current	V_{IN} = 1.2V	V_{OUT} = 3.3V	MAX848		110		mA
			MAX849		300		
		V_{OUT} = 5V	MAX848		70		
			MAX849		200		
	V_{IN} = 2.4V	V_{OUT} = 3.3V	MAX848		200		
			MAX849		750		
		V_{OUT} = 5V	MAX848		130		
			MAX849		500		
	V_{IN} = 2.7V	V_{OUT} = 3.3V	MAX848		250		
			MAX849		600		
		V_{OUT} = 5V	MAX848		150		
			MAX849		800		
	V_{OUT} = 5V	MAX848, V_{IN} = 3.3V			300		
		MAX849, V_{IN} = 3.6V			1000		
FB Regulation Voltage	Adjustable output, CLK/SEL = OUT			1.215	1.240	1.265	V
FB Input Current	V_{FB} = 1.25V					200	nA
Output Voltage Adjust Range				2.7		5.5	V
Output Voltage Lockout Range	(Note 3)			2.1		2.4	V
Load Regulation (Note 4)	CLK/SEL = OUT				-1.6		%
Minimum Start-Up Voltage (Note 5)	I_{LOAD} < mA, T_A > +25°C				0.9	1.1	V
Frequency in Start-Up Mode	V_{OUT} = 1.5V			40		300	kHz
Operating Current in Shutdown	Current into OUT pin, $V_{\overline{ON2}}$ = 3.6				4	20	µA

ELECTRICAL CHARACTERISTICS (continued)

(V_{OUT} = 3.6V, GND = PGND = CLK/SEL = ON1 = $\overline{ON2}$ = AINSEL = AIN1 = AIN2 = FB = POKIN, POUT = OUT, **T_A = 0°C to +85°C**, unless otherwise noted.)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Operating Current in Low-Power Mode (Note 6)	Current into OUT pin, CLK/SEL = GND			35	90	µA
Operating Current in Low-Noise Mode (Note 6)	Current into OUT pin, CLK/SEL = OUT, does not include switching losses			150	300	µA
DC-DC SWITCHES						
POUT Leakage Current	V_{LX} = 0V, $V_{\overline{ON2}}$ = V_{OUT} = 5.5V			0.1	20	µA
LX Leakage Current	V_{LX} = $V_{\overline{ON2}}$ = V_{OUT} = 5.5V			0.1	20	µA
Switch On-Resistance	N-channel	CLK/SEL = GND		0.3	0.6	Ω
		CLK/SEL = OUT		0.13	0.25	
	P-channel	CLK/SEL = OUT		0.25	0.5	
N-Channel Current Limit	CLK/SEL = OUT	MAX848		0.3	0.6	mA
		MAX849	1100	1350	1600	
	$V_{CLK/SEL}$ = 0V (Note 7)	MAX848	120	200	300	
		MAX849	250	400	550	
ADC						
Data Output Voltage Low	I_{SINK} = 1mA				0.4	V
Data Output Voltage High	I_{SOURCE} = 1mA		V_{OUT} - 0.4			V
AIN1 Input Range	AINSEL = GND		0.625		1.875	V
AIN2 Input Range	AINSEL = OUT		0		2.5	V
AIN1, AIN2 Input Current	f_{CLK} = 400kHz, V_{AIN1} = V_{AIN2} = 2.5V			1	2	µA
Accuracy	f_{CLK} = 400kHz, 5ms conversion, monotonic to 8 bits				±4	% FSR
POWER-GOOD						
Internal Trip Level	Rising V_{OUT}, V_{POKIN} < 0.1V		2.95		3.10	V
External Trip Level	Rising V_{POKIN}		1.225		1.275	V
POK Low Voltage	I_{SINK} = 1mA, V_{OUT} = 3.6V or I_{SINK} = 20µA, V_{OUT} = 1V				0.4	V
POK High Leakage Current	V_{OUT} = V_{POK} = 5.5V			0.01	1	µA
POKIN Leakage Current	V_{POKIN} = 1.5V				50	nA
LOGIC AND CONTROL INPUTS						
Input Low Voltage	1.2V < V_{OUT} < 5.5V, ON1 and $\overline{ON2}$ (Note 8)				0.2V_{OUT}	V
	V_{OUT} = 2.7V, AINSEL and CLK/SEL				0.2V_{OUT}	
Input High Voltage	1.2V < V_{OUT} < 5.5V, ON1 and $\overline{ON2}$ (Note 8)		0.8V_{OUT}			V
	V_{OUT} = 5.5V, AINSEL and CLK/SEL		0.8V_{OUT}			
Logic Input Current	ON1, $\overline{ON2}$, AINSEL and CLK/SEL				1	µA
Internal Oscillator Frequency	CLK/SEL = OUT		260	300	340	kHz
Oscillator Maximum Duty Cycle			80	85	90	%
External Clock Frequency Range			200		400	kHz
CLK/SEL Pulse Width	Not tested		200			ns
CLK/SEL Rise/Fall Time	Not tested				100	ns

1-Cell to 3-Cell, High-Power, Low-Noise, Step-Up DC-DC Converters

ELECTRICAL CHARACTERISTICS

(V_{OUT} = 3.6V, GND = PGND = CLK/SEL = ON1 = $\overline{ON2}$ = AINSEL = AIN1 = AIN2 = FB = POKIN, POUT = OUT, **T_A = -40°C to +85°C**, unless otherwise noted.) (Note 9)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
REFERENCE						
Reference Output Voltage	I_{REF} = 0mA		1.225		1.275	V
DC-DC CONVERTER						
Output Voltage (Note 3)	V_{FB} < 0.1V, CLK/SEL = OUT, includes load-regulation error		3.13		3.47	V
FB Regulation Voltage	Adjustable output, CLK/SEL = OUT		1.21		1.27	V
Output Voltage Lockout Range	(Note 3)		2.05		2.45	V
OUT Supply Current in Shutdown	$V_{\overline{ON2}}$ = 3.6V				20	µA
OUT Supply Current in Low-Power Mode (Note 6)	CLK/SEL = GND				90	µA
OUT Supply Current in Low-Noise Mode (Note 6)	CLK/SEL = OUT, does not include switching losses				300	µA
DC-DC SWITCHES						
Switch On-Resistance	N-channel	CLK/SEL = GND			0.6	Ω
		CLK/SEL = OUT			0.25	
	P-channel	CLK/SEL = OUT			0.5	
N-Channel Current Limit	CLK/SEL = OUT	MAX848	600		1100	mA
		MAX849	1100		1800	
	CLK/SEL = GND (Note 7)	MAX848	120		300	
		MAX849	250		550	
ADC						
Accuracy	f_{CLK} = 400kHz, 5ms conversion				±4	% FSR
POWER-GOOD						
Internal Trip Level	Rising V_{OUT}, V_{POKIN} < 0.1V		2.95		3.10	V
External Trip Level	Rising V_{POKIN}		1.225		1.275	V
LOGIC CONTROL INPUTS						
Internal Oscillator Frequency	CLK/SEL = OUT		260		340	kHz
Oscillator Maximum Duty Cycle			80		90	%

Note 1: Minimum operating voltage. Because the MAX848/MAX849 are bootstrapped to the output, it will operate down to a 0.7V input.

Note 2: In low-power mode (CLK/SEL = GND), the output voltage regulates 1% higher than in low-noise mode (CLK/SEL = OUT or synchronized).

Note 3: The part is in start-up mode until it reaches this voltage level. Do not apply full-load current.

Note 4: Load regulation is measured from no load to full load, where full load is determined by the N-channel switch current limit.

Note 5: Start-up is tested with Figure 2's circuit. Output current is measured when the input and output voltages are applied.

Note 6: Supply current from the 3.34V output is measured between the 3.34V output and the OUT pin. This current correlates directly with actual battery supply current, but is reduced in value according to the step-up ratio and efficiency. V_{OUT} = 3.6V to keep the internal switch open when measuring the current into the device.

Note 7: When $V_{CLK/SEL}$ = 0V, the inductor is forced into constant-peak-current, discontinuous operation. This is guaranteed by testing in Figure 2's circuit.

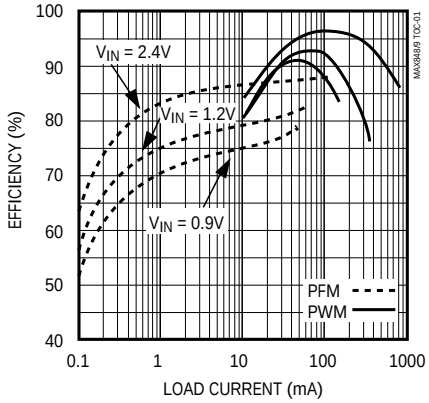
Note 8: ON1 and $\overline{ON2}$ inputs have approximately 0.15V_{OUT} hysteresis.

Note 9: Specifications to -40°C are guaranteed by design, not production tested.

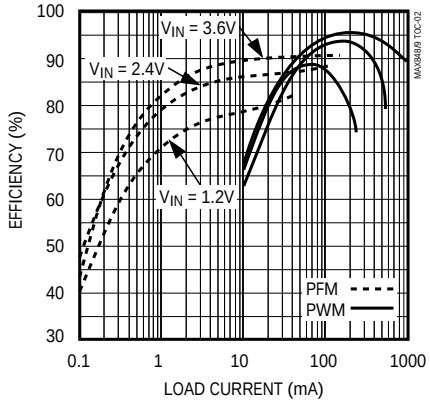
Typical Operating Characteristics

(T_A = +25°C, unless otherwise noted.)

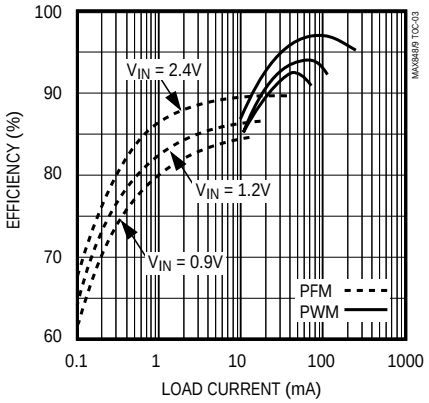
MAX849
EFFICIENCY vs. LOAD CURRENT
(V_{OUT} = 3.3V)



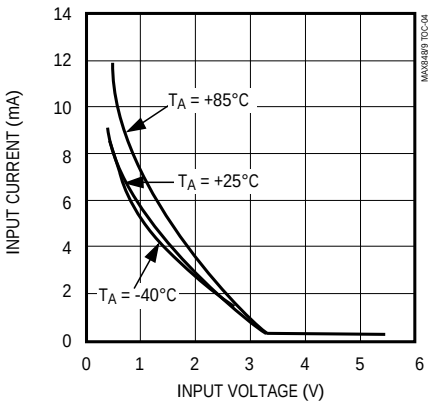
MAX849
EFFICIENCY vs. LOAD CURRENT
(V_{OUT} = 5V)



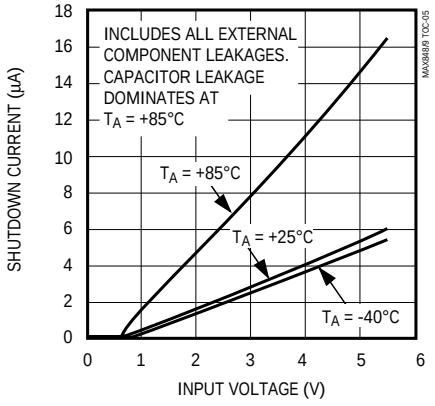
MAX848
EFFICIENCY vs. LOAD CURRENT
(V_{OUT} = 3.3V)



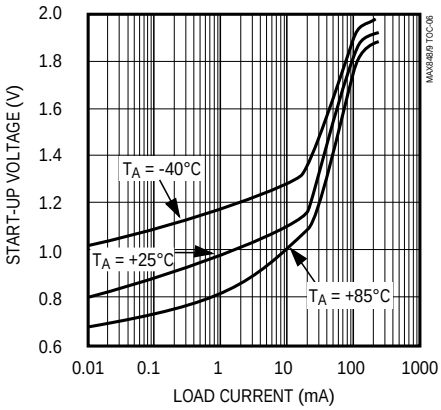
NO-LOAD BATTERY CURRENT
vs. INPUT VOLTAGE



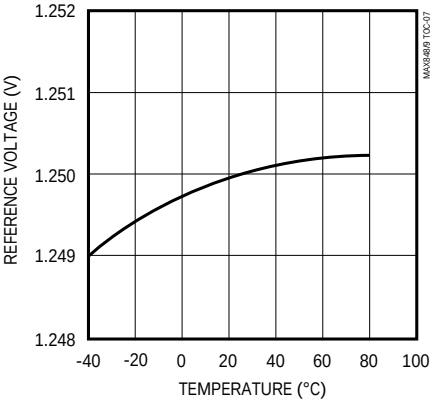
SHUTDOWN CURRENT
vs. INPUT VOLTAGE


MAX849/9 TOC-05
SHUTDOWN CURRENT (µA)
INPUT VOLTAGE (V)
INCLUDES ALL EXTERNAL COMPONENT LEAKAGES. CAPACITOR LEAKAGE DOMINATES AT TA = +85°C
TA = +85°C
TA = +25°C
TA = -40°C

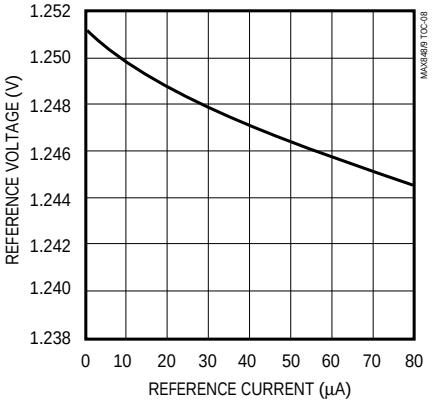
START-UP VOLTAGE vs. LOAD CURRENT
(V_{OUT} = 3.3V, PWM MODE)



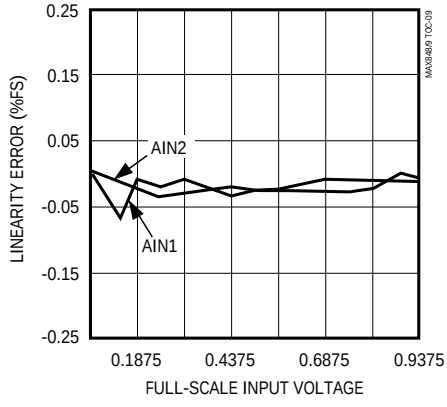
REFERENCE VOLTAGE
vs. TEMPERATURE



REFERENCE VOLTAGE
vs. REFERENCE CURRENT



ADC LINEARITY ERROR
vs. FULL-SCALE INPUT VOLTAGE

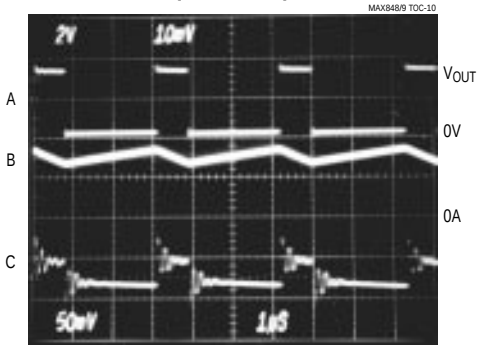


1-Cell to 3-Cell, High-Power, Low-Noise, Step-Up DC-DC Converters

Typical Operating Characteristics (continued)

(T_A = +25°C, unless otherwise noted.)

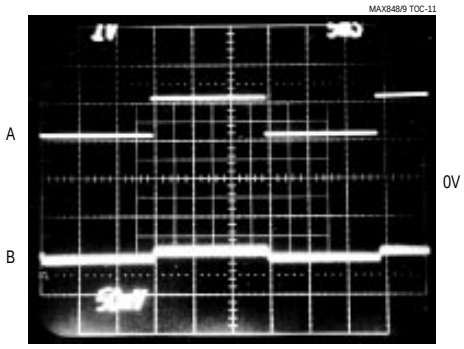
HEAVY-LOAD SWITCHING WAVEFORMS (V_{OUT} = 3.3V)



1µs/div

V_{IN} = 1.1V, I_{OUT} = 200mA, V_{OUT} = 3.3V
A = LX VOLTAGE, 2V/div
B = INDUCTOR CURRENT, 0.5A/div
C = V_{OUT} RIPPLE, 50mV/div, AC COUPLED

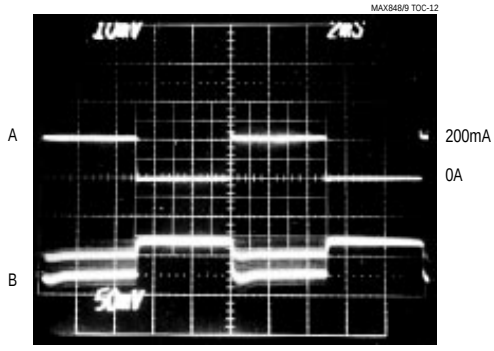
LINE-TRANSIENT RESPONSE



5ms/div

I_{OUT} = 0mA, V_{OUT} = 3.3V
A = V_{IN}, 1.1V TO 2.1V, 1V/div
B = V_{OUT} RIPPLE, 50mV/div, AC COUPLED

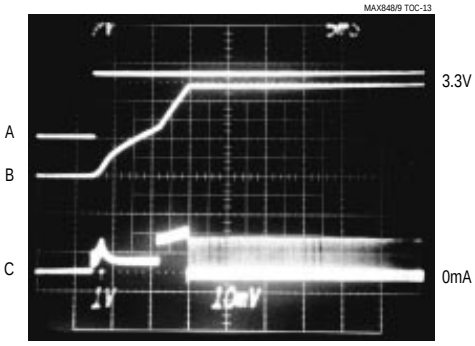
LOAD-TRANSIENT RESPONSE



2ms/div

V_{IN} = 1.1V, V_{OUT} = 3.3V
A = LOAD CURRENT, 0mA TO 200mA, 0.2A/div
B = V_{OUT} RIPPLE, 50mV/div, AC COUPLED

POWER-ON DELAY (PFM MODE)



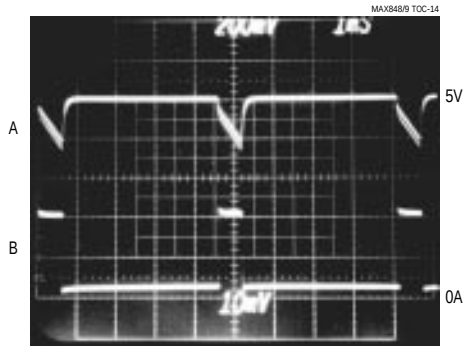
5ms/div

A = V_{ON1}, 2V/div
B = V_{OUT}, 1V/div
C = INPUT CURRENT, 0.2A/div

Typical Operating Characteristics (continued)

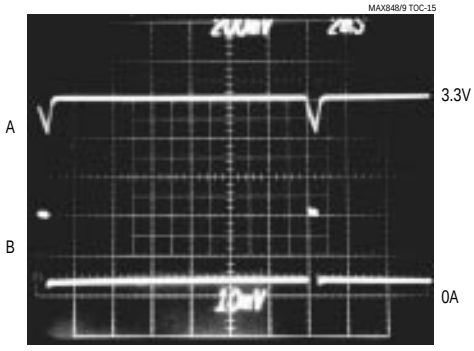
(T_A = +25°C, unless otherwise noted.)

MAX849
GSM LOAD-TRANSIENT RESPONSE



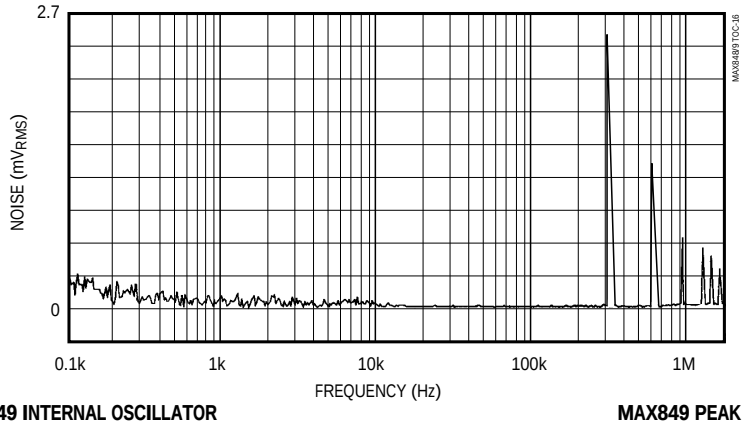
V_{IN} = 3.6V, V_{OUT} = 5V, C_{OUT} = 440µF
A = V_{OUT} RIPPLE, 200mV/div, AC COUPLED
B = LOAD CURRENT, 100mA TO 1A, 0.5A/div,
PULSE WIDTH = 577µs

MAX849
DECT LOAD-TRANSIENT RESPONSE

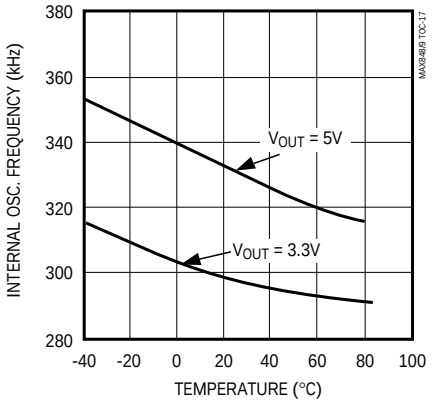


V_{IN} = 1.2V, V_{OUT} = 3.3V, C_{OUT} = 440µF
A = V_{OUT} RIPPLE, 200mV/div, AC COUPLED
B = LOAD CURRENT, 50mA TO 400mA, 0.2A/div,
PULSE WIDTH = 416µs

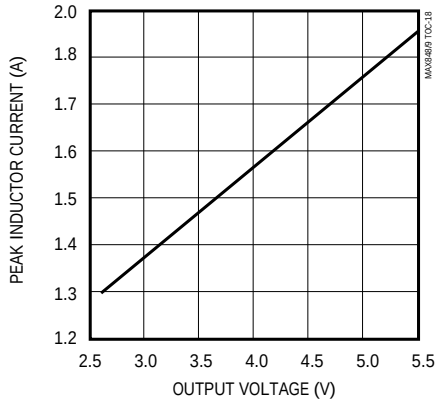
MAX849 NOISE SPECTRUM
(V_{OUT} = 3.3V, V_{IN} = 1.2V, R_{LOAD} = 50Ω)



MAX849 INTERNAL OSCILLATOR
FREQUENCY vs. TEMPERATURE



MAX849 PEAK INDUCTOR CURRENT
vs. OUTPUT VOLTAGE



1-Cell to 3-Cell, High-Power, Low-Noise, Step-Up DC-DC Converters

Pin Description

PIN	NAME	FUNCTION
1	AIN1	ADC's Channel 1 Input. Analog input voltage range is 0.625V to 1.875V.
2	AIN2	ADC's Channel 2 Input. Analog input voltage range is 0V to 2.5V.
3	REF	Reference Output. Bypass with a 0.22µF capacitor to GND.
4	GND	Ground. Use for low-current ground paths. Connect to PGND with a short trace.
5	OUT	Output Sense Input. The IC is powered from OUT. Bypass to GND with a 0.1µF ceramic capacitor. Connect OUT to POUT through a 10Ω series resistor.
6	POKIN	Power-Good Comparator Input. Connect to GND for fixed threshold (V_{OUT} x 0.9). To adjust the threshold, connect to a resistor divider from OUT to GND.
7	FB	Dual Mode DC-DC Converter Feedback Input. Connect to GND for fixed 3.3V output voltage. Connect to a resistor divider from OUT to GND to adjust the output voltage. Minimize noise coupling from switching signals to FB.
8	POK	Power-Good Output. This open-drain output is pulled low when the output voltage (V_{OUT}) drops below the internally set threshold (fixed threshold), or when the voltage at POKIN drops below V_{REF} (adjustable threshold).
9	AINSEL	ADC's Input Channel Selector. Pull low to select AIN1 and drive high to select AIN2.
10	DATA	ADC's Serial Output. Pulsed output, RZ format. Full scale is $f_{OSC}/2$ ($f_{CLK}/2$ in external sync mode). The DATA output is low when $V_{CLK/SEL}$ = 0V (PFM mode).
11	CLK/SEL	External Clock Input/Regulator's Switching Mode Selector. CLK/SEL = low: low-power, low-quiescent PFM mode. Delivers 100mW of output power. CLK/SEL = high: low-noise, high-power PWM mode, switching at a constant frequency (300kHz). CLK/SEL = driven with external clock: low-noise, high-power, synchronized PWM mode. The internal oscillator is synchronized to the external clock (200kHz ~ 400kHz). Turning the DC-DC converter on with $V_{CLK/SEL}$ = 0V also serves as a soft-start function, since the peak inductor current is limited to 30% of the nominal value.
12	PGND	Source of the Internal N-Channel Power MOSFET. Connect to high-current ground path.
13	LX	Drain of the Internal N-Channel Power MOSFET and P-Channel Synchronous Rectifier
14	POUT	Source of the Internal P-Channel Synchronous Rectifier MOSFET. Connect an external Schottky diode from LX to POUT. Bypass to PGND with a 0.1µF ceramic capacitor as close to the IC as possible.
15	$\overline{ON2}$	OFF Control Input. When ON1 = 0 and $\overline{ON2}$ = 1, the IC is off.
16	ON1	ON Control Input. When ON1 = 1 or $\overline{ON2}$ = 0, the IC is on.

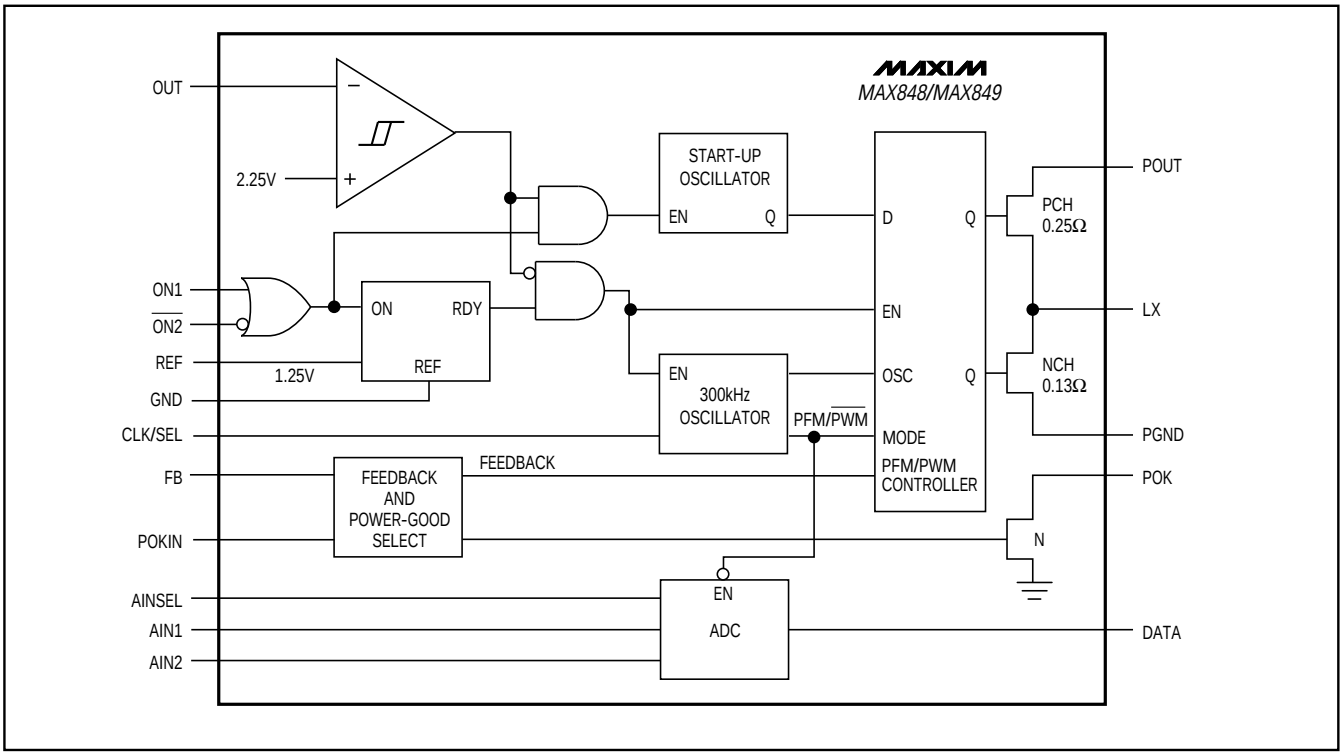


Figure 1. Functional Diagram

Detailed Description

The MAX848/MAX849 combine a switching regulator, N-channel power MOSFET, P-channel synchronous rectifier, precision reference voltage, power-good indicator, and battery voltage monitor, all in a single monolithic device. The MAX848/MAX849 are powered directly from the output. The output voltage is factory preset to 3.3V or adjustable from 2.7V to 5V with external resistors (Dual Mode™ operation). These devices start from a low 1V input voltage and remain operational down to 0.7V. The MAX848/MAX849 operate with either one to three NiCd/NiMH cells or one Li-Ion cell.

At power-up, an internal low-voltage oscillator drives the N-channel power switch, and the output voltage slowly builds up. The oscillator has a 25% nominal duty cycle to prevent current build-up in the inductor. An output voltage in excess of the nominal 2.25V lockout voltage activates the error comparator and internal timing circuitry. The device resumes operation in either pulse-frequency-modulation (PFM) low-power mode or pulse-width-modulation (PWM) low-noise mode, selected by the logic control, CLK/SEL. Figure 2 shows the standard application circuit for the MAX849 configured in the high-power PWM mode.

On/Off Control

The MAX848/MAX849 are turned on or off by logic input pins ON1 and $\overline{ON2}$ (Table 1). When ON1 = 1 or $\overline{ON2}$ = 0, the part is on. When ON1 = 0 and $\overline{ON2}$ = 1, the part is off. Both inputs have logic trip points near 0.5 x V_{OUT} with 0.15 x V_{OUT} hysteresis.

Table 1. On/Off Logic Control

ON1	$\overline{ON2}$	MAX848/MAX849
0	0	On
0	1	Off
1	0	On
1	1	On

Operating Modes

The MAX848/MAX849 operate in either PFM, PWM, or PWM synchronized to an externally applied clock signal. Table 2 lists each operating mode.

1-Cell to 3-Cell, High-Power, Low-Noise, Step-Up DC-DC Converters

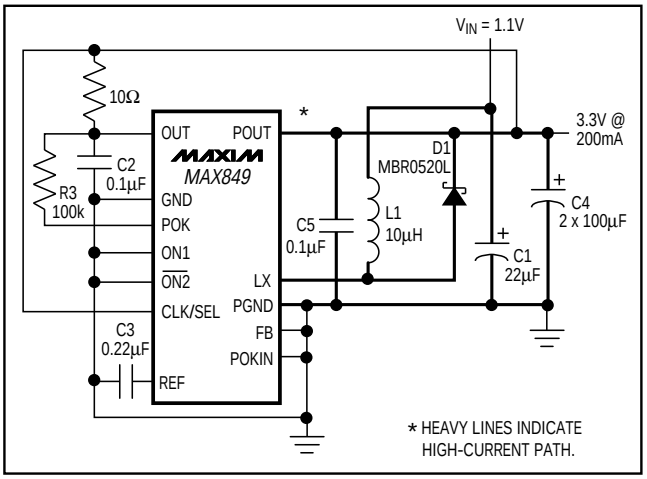


Figure 2. 3.3V Preset Output

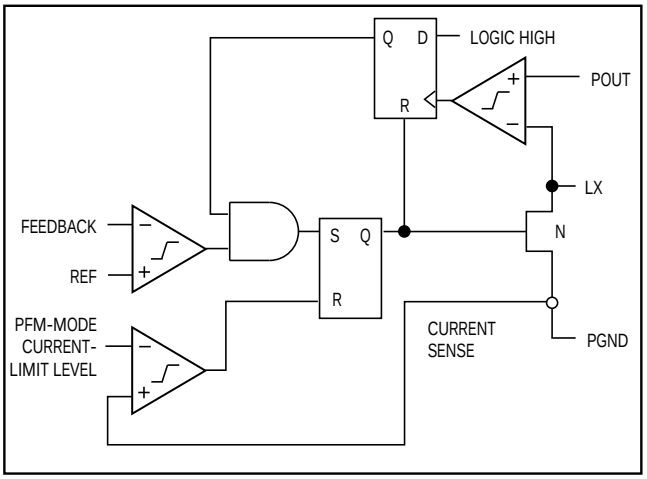


Figure 3. Controller Block Diagram in PFM Mode

Table 2. Selecting Operating Mode

CLK/SEL	MODE
0	PFM
1	PWM
External clock (200kHz ~ 400kHz)	Synchronized PWM

Low-Power PFM Mode

When CLK/SEL is pulled low, the MAX848/MAX849 operate in low-power, low-supply-current PFM mode. Pulse-frequency modulation provides the highest efficiency at light loads. The P-channel rectifier is turned off to reduce gate-charge losses, and the regulator operates in discontinuous mode. The N-channel power MOSFET is kept on until the inductor current ramps to 30% of the current limit. The inductor energy is delivered to the output capacitor when the switch turns off. A new cycle is inhibited until the inductor current crosses zero. Zero current detection is accomplished by sensing the LX voltage crossing the output voltage. Figure 3 shows the block diagram for the PFM controller.

Low-Noise PWM Mode

When CLK/SEL is pulled high, the MAX848/MAX849 operate in high-power, low-noise, current-mode PWM, switching at the 300kHz nominal internal oscillator frequency. The internal rectifier is active in this mode, and the regulator operates in continuous mode. The N-channel power MOSFET turns on until either the output voltage is in regulation or the inductor current limit is reached (0.8A for the MAX848 and 1.4A for the MAX849). The switch turns off for the remainder of the cycle and the inductor energy is delivered to the output capacitor. A new cycle is initiated on the next oscillator cycle. In low-noise applications, the fundamental and the harmonics generated by the fixed switching frequency can easily be filtered. Figure 4 shows the block diagram for the PWM controller.

The MAX848/MAX849 enter synchronized current-mode PWM when a clock signal (200kHz < f_{CLK} < 400kHz) is applied to CLK/SEL. The internal synchronous rectifier is active and the switching frequency is synchronized to the externally applied clock signal. For wireless applications, this ensures that the harmonics of the switching frequencies are predictable and can be kept outside the IF band(s). High-frequency operation permits low-magnitude output ripple voltage.

The MAX848/MAX849 are capable of providing a stable output even with a rapidly pulsing load (GSM, DECT), such as from a transmitter power amplifier in digital cordless phones (see *Typical Operating Characteristics*).

In PWM mode, the use of the synchronous rectifier ensures constant-frequency operation, regardless of the load current.

Setting the Output Voltage Externally

The MAX848/MAX849 feature Dual Mode operation. The output voltage is preset to 3.3V (FB = 0V), or it can be adjusted from 2.7V to 5.5V with external resistors R1, R2, and R3, as shown in Figure 5. To set the output voltage externally, select resistor R3 in the 10kΩ to 100kΩ range. The values for R1 and R2 are given by:

$$R2 = R3(V_{OUT} / V_{TRIP} - 1)$$

$$R1 = (R3 + R2)(V_{TRIP} / V_{REF} - 1)$$

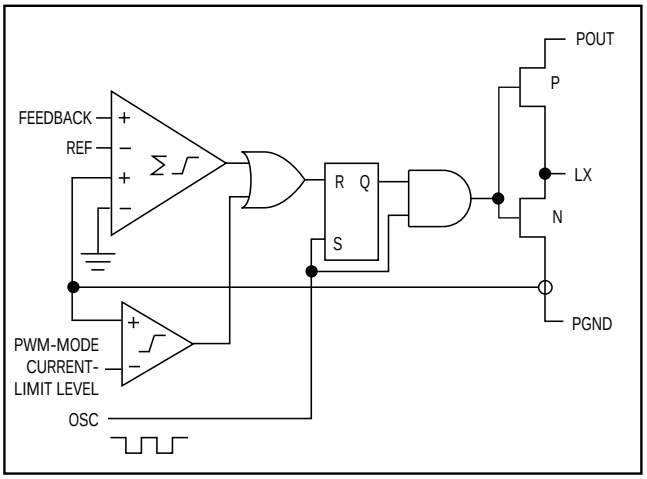


Figure 4. Controller Block Diagram in PWM Mode

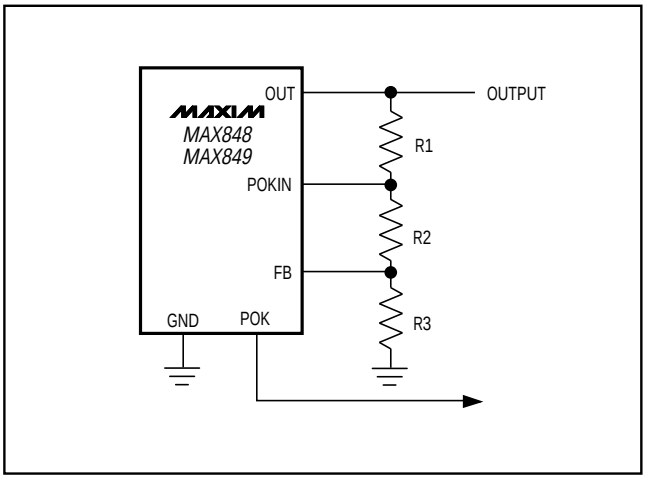


Figure 5. Adjustable Output Voltage and Power-Good Trip Level

where V_{REF} = 1.25V, V_{OUT} is the desired output voltage, and V_{TRIP} is the desired trip level for the power-good comparator.

Power-OK

The MAX848/MAX849 feature a power-good comparator. This comparator's open-drain output, POK, is pulled low when the output voltage falls below the nominal internal threshold level of 3V with POKIN = 0V. To set the power-good trip level externally, refer to the *Setting the Output Voltage Externally* section.

Analog-to-Digital Converter (ADC)

The MAX848/MAX849 have an internal, two-channel, serial ADC. The ADC converts an analog input voltage into a digital stream available at the DATA pin. The converter skips clock pulses in proportion to the input voltage. Output format is a return-to-zero bit stream with a bit duration of $1/f_{CLK}$. At zero-scale input voltage, all pulses are skipped and DATA remains low; with a positive full-scale input voltage, no pulses are skipped; and at mid-scale, every other pulse is skipped. The ADC's clock is one-half of the externally applied clock signal or one-half of the internal 300kHz clock available at LX. In PFM mode, the converter is not active and DATA is driven low.

Channel 1, AIN1, has an input voltage range of 0.625V to 1.875V and is selected when AINSEL is low. Channel 2, AIN2, accepts inputs in the 0V to 2.5V range and is selected when AINSEL is pulled high (Figure 6).

The ADC is a switched-capacitor type; therefore, an anti-aliasing filter might be required at the inputs. Insert a 1kΩ series resistor and a 0.01µF filter capacitor in noisy environments.

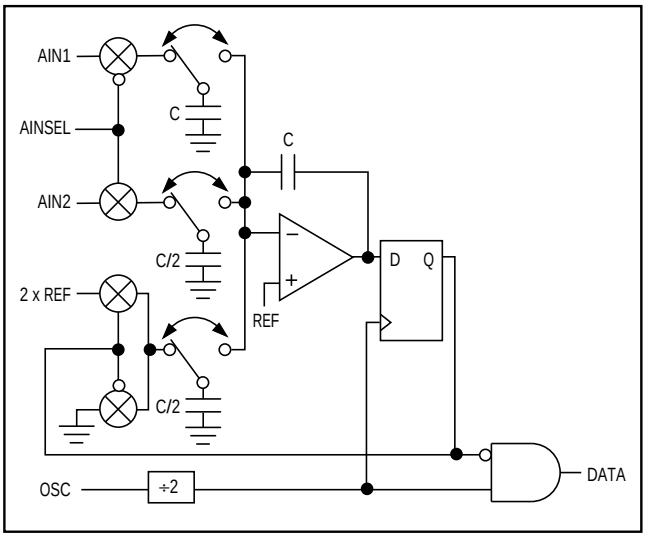


Figure 6. A/D Converter Block Diagram

Timer Function Implementation

Implement the necessary counter functions either with discrete hardware or with microcontroller (µC) implementations. The output resolution depends on how many of the ADC clock pulses are counted, as shown in Figure 7.

Hardware Implementation

A complete hardware solution can be implemented using either two counters or an ASIC. Resolution depends on how many pulses are counted. The main advantage of the discrete hardware implementation is that accuracy is not affected by interrupt latency associated with the µC solution.

1-Cell to 3-Cell, High-Power, Low-Noise, Step-Up DC-DC Converters

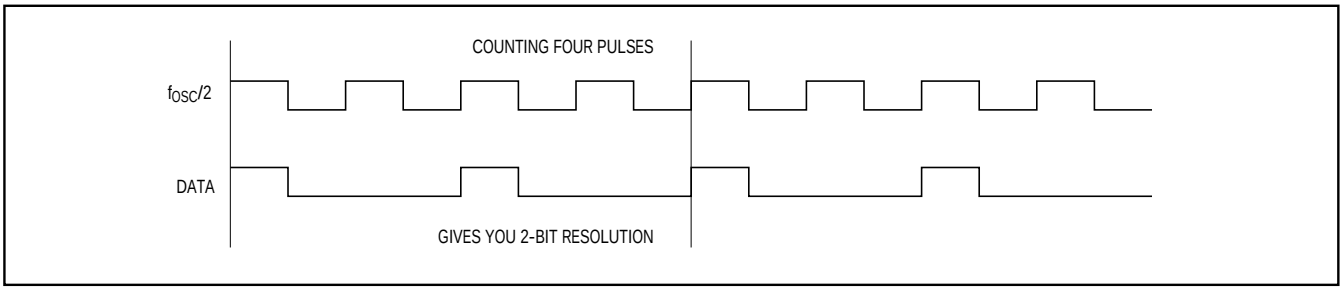


Figure 7. Bit Stream at 1/2 Full Scale

When using two counters of the same length, as shown in Figure 8, one counter (A) just counts the A/D clock pulses ($f_{OSC}/2$), and the other counter (B) counts DATA output pulses. When counter A overflows (for example, after 256 clock cycles for an 8-bit counter), counter B is disabled. The controller reads the counter B output data and calculates the analog voltage present at the ADC's input.

All µC Implementation

This implementation uses a µC timer and a counter. The timer and the counter are reset at the same time. The counter counts data-output pulses applied at its input. When the timer times out, an interrupt is asserted. The µC then reads the state of the counter register. The interrupt-handling overhead can cause the counter to count more pulses than desired. Accuracy depends on how long the µC needs to read the counter. No errors will occur if the counter is disabled within one clock period. Interrupt latency reduces accuracy. The main advantage of this implementation is that no external hardware is required.

Design Procedure

Inductor Selection

The MAX848/MAX849's high switching frequency allows the use of a small inductor. Use a 10µH inductor for the MAX849 and a 22µH inductor for the MAX848. Inductors with a ferrite core or equivalent are recommended; powder iron cores are not recommended for use with high switching frequencies. Make sure the inductor's saturation rating (the current at which the core begins to saturate and inductance starts to fall) exceeds the internal current limit: 0.8A for the MAX848 and 1.4A for the MAX849. However, it is generally acceptable to bias the inductor into saturation by approximately 20% (the point where the inductance is 20% below the nominal value). For highest efficiency, use a coil with low DC resistance, preferably under 100mΩ. To minimize radiated noise, use a toroid, pot core, or shielded inductor. See Table 5 for a list of suggested inductor suppliers.

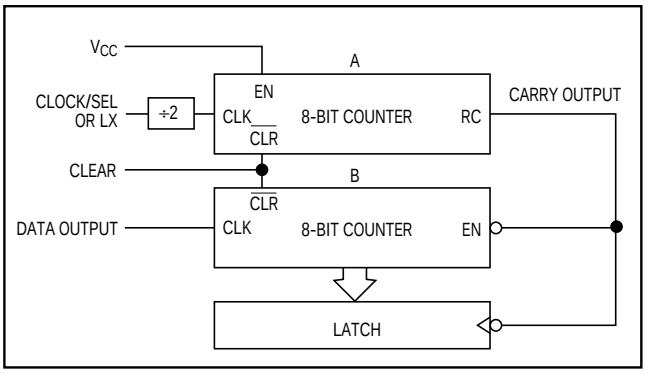


Figure 8. Discrete Hardware Solution for Counting A/D Output Data Pulses

Diode Selection

The MAX848/MAX849's high switching frequency demands a high-speed rectifier. Schottky diodes, such as the 1N5817 or MBR0520L, are recommended. Make sure the diode's current rating exceeds the maximum load current and that its breakdown voltage exceeds V_{OUT}.

The Schottky rectifier diode carries load currents only in the PFM operating mode, since the P-channel synchronous rectifier is disabled. Therefore, the current rating need not be high (0.5A is sufficient). In PFM mode, the voltage drop across the rectifier diode causes efficiency loss. However, when operating in PWM mode, the internal P-channel synchronous rectifier is active and efficiency loss due to the rectifier diode is minimized.

For high-temperature applications, Schottky diodes may be inadequate due to their high leakage currents; use high-speed silicon diodes such as the MUR105 or EC11FS1. At heavy loads and high temperatures, the benefits of a Schottky diode's low forward voltage may outweigh the disadvantage of high leakage current. See Table 4 for a list of suggested diode suppliers.

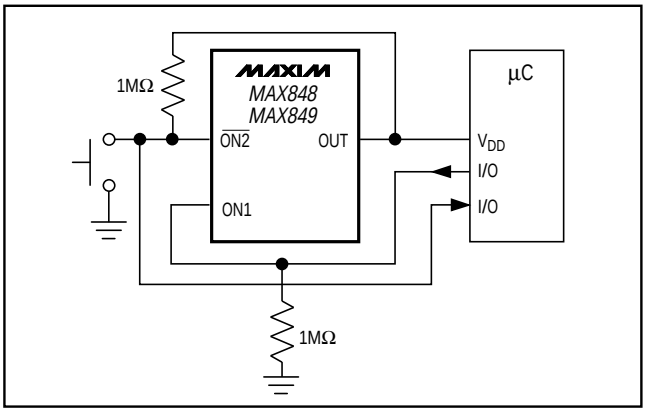


Figure 9. Momentary Pushbutton On/Off Switch

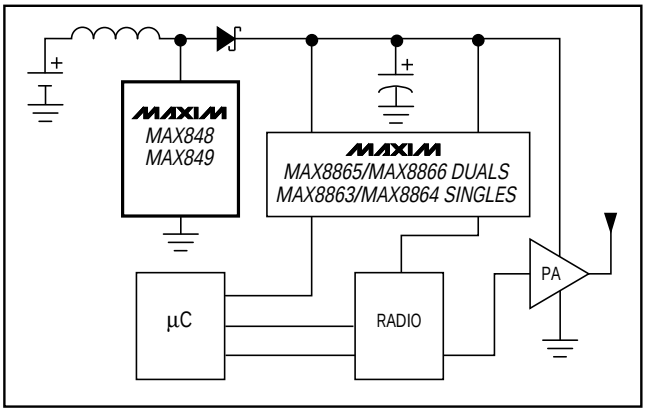


Figure 10. Typical Phone Application

Capacitor Selection

Input Bypass Capacitors

A 22µF, low-ESR input capacitor will reduce peak currents and reflected noise due to inductor current ripple. Smaller ceramic capacitors may also be used for light loads or in applications that can tolerate higher input ripple.

Output Filter Capacitors

Two 100µF (single 100µF for the MAX848), 10V, low-ESR, output filter capacitors typically exhibit 30mV ripple when stepping up from 1.2V to 3.3V at 200mA (100mA for the MAX848). Bypass the MAX848/MAX849 supply input, OUT, with a 0.1µF ceramic capacitor to GND. Also bypass POUT to PGND with a 0.1µF ceramic capacitor.

The filter capacitors' equivalent series resistance (ESR) affects efficiency and output ripple. The output voltage ripple is the product of the peak inductor current and the output capacitor's ESR. Low-ESR, surface-mount tantalum capacitors are currently available from Sprague (595D series) and AVX (TPS series). Sanyo OS-CON organic-semiconductor, through-hole capacitors also exhibit very low ESR, and are especially useful for operation at cold temperatures. See Table 5 for a list of suggested capacitor suppliers.

Applications Information

Using a Momentary On/Off Switch

A momentary pushbutton switch can be used to turn the MAX848/MAX849 on and off.

As shown in Figure 9, ON1 is pulled low and $\overline{ON2}$ is pulled high when the part is off. When the momentary switch is pressed, $\overline{ON2}$ is pulled low and the regulator turns on. The switch should be on long enough for the µC to exit reset. The controller issues a logic high to ON1, which guarantees that the part will stay on, regardless of the switch state.

To turn off the regulator, the switch is pressed and held. The controller reads the switch status and pulls ON1 low. The switch is released and $\overline{ON2}$ is pulled high.

Power Amplifier (PA) and Radio Supply in a Typical Phone Application

The MAX849 is an ideal power supply for the power amplifier (PA) and the radio used in digital cordless and PCS phones (Figure 10). The PA is directly powered by the MAX849 for maximum output swing. Post-linear regulators power the controller and the radio. In addition, they reduce switching noise and ripple. Table 3 lists the output power available when operating with one or more NiCd/NiMH cells or one Li-Ion cell.

Table 3. Available Output Power

NUMBER OF CELLS	INPUT VOLTAGE (V)	OUTPUT VOLTAGE: PA POWER SUPPLY (V)	OUTPUT POWER (W)
1 NiCd/NiMH	1.2	3.3	0.9
2 NiCd/NiMH	2.4	3.3	2.4
2 NiCd/NiMH	2.4	5.0	2.6
3 NiCd/NiMH or 1 Li-Ion	3.6	5.0	4.3

1-Cell to 3-Cell, High-Power, Low-Noise, Step-Up DC-DC Converters

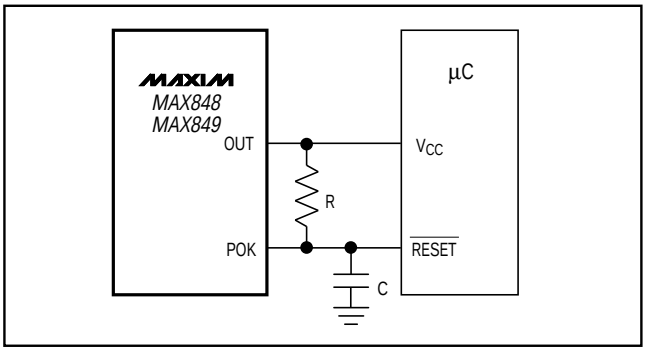


Figure 11. Power-On Reset Delay

Power-On Reset Delay

Adding a timing capacitor from POK to GND generates a power-on reset delay. The reset time constant is determined by the pull-up resistor and timing capacitor (Figure 11). When power is turned on, POK is low and the capacitor is shorted. When the output voltage reaches regulation, POK goes high and the capacitor slowly charges to the output voltage.

The timing resistor value depends on the controller's RESET input leakage current. The voltage drop across the timing resistor should not exceed the difference between the output voltage and the µC reset threshold voltage. This resistor should be large enough to minimize the shutdown current.

µC-Controlled Shutdown

The MAX848/MAX849 turn on when ON1 = 1 or $\overline{ON2}$ = 0. The µC monitors the battery voltage and turns off the device (forces ON1 low and $\overline{ON2}$ high) when the battery is weak.

Layout Considerations

Due to high inductor current levels and fast switching waveforms, which radiate noise, proper PC board layout is essential. Protect sensitive analog grounds by using a star ground configuration. Minimize ground noise by connecting PGND, the input bypass capacitor ground lead, and the output filter capacitor ground lead to a single point (star ground configuration). Also, minimize lead lengths to reduce stray capacitance and trace resistance.

If an external resistor divider is used to set the output voltage (Figure 5), the trace from FB to the resistors must be extremely short and must be shielded from switching signals, such as CLK, DATA, or LX.

Table 4. Component Selection Guide

PRODUCTION	INDUCTORS	CAPACITORS	DIODES
Surface Mount	Sumida CDR63B, CD73, CDR73B, CD74B series Coilcraft DO1608, DO3308, DT3316 series	Matsuo 267 series Sprague 595D series AVX TPS series	Motorola MBR0520L
Through Hole	Sumida RCH654 series	Sanyo OS-CON series Nichicon PL series	Motorola 1N5817

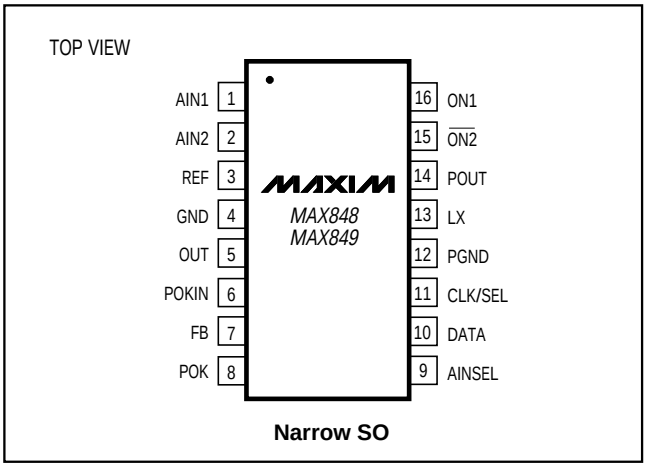
Table 5. Component Suppliers

SUPPLIER	PHONE	FAX
AVX	USA: (803) 946-0690 (800) 282-4975	(803) 626-3123
Coilcraft	USA: (847) 639-6400	(847) 639-1469
Matsuo	USA: (714) 969-2491	(714) 960-6492
Motorola	USA: (602) 303-5454	(602) 994-6430
Sanyo	USA: (619) 661-6835 Japan: 81-7-2070-6306	(619) 661-1055 81-7-2070-1174
Sumida	USA: (847) 956-0666 Japan: 81-3-3607-5111	(847) 956-0702 81-3-3607-5144

Chip Information

TRANSISTOR COUNT: 2059

Pin Configuration



1-Cell to 3-Cell, High-Power, Low-Noise, Step-Up DC-DC Converters

NOTES

Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

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INDUCTORS DESIGNED FOR NATIONAL'S 50 KHz SIMPLE SWITCHER™

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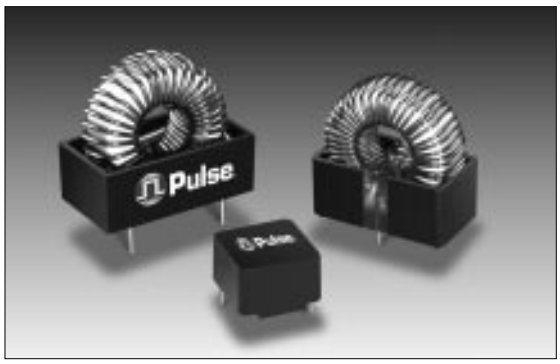

- Designed for use with National's device numbers LM2574/LM2575/LM2576
- Base material meets flammability requirements of UL 94V-0
- Performance verified by National Semiconductor

Electrical Specifications @ 25°C— Operating Temperature -30° to +130° C

Part Identification		Reference Operating Values[1]			Design Control Values			
Part Number	Inductor Code	Inductance Typical (µH)	I_{DC} (Amps)	ET_{OP} (V-µSec)	Inductance No DC[2] (µH ± 20%)	DCR (Ω MAX)	Package Style	Lead Diameter
PE-53112	L47	47	3.0	90	38	0.05	KM-2.0	.025
PE-92114K	L68	68	3.0	90	55	0.02	KM-4.0	.040
PE-92108K	L100	100	3.0	90	91	0.04	KM-4.0	.032
PE-53113	L150	150	2.0	90	130	0.10	KM-4.0	.025
PE-52626	L220	220	1.4	90	230	0.38	Low Profile	.025 SQ.
PE-53145	L220	220	1.4	90	176	0.14	KM-3.0	.020
PE-52627	L330	330	0.9	90	302	0.74	Low Profile	.025 SQ.
PE-53146	L330	330	0.9	90	267	0.18	KM-3.0	.020
PE-53114	L470	470	0.64	90	426	0.16	KM-4.0	.025
PE-52629	L680	680	.85	90	657	1.25	Low Profile	.025 SQ.
PE-53115	H150	150	3.0	200	136	0.10	KM-4.0	.025
PE-53116	H220	220	3.0	200	167	0.07	KM-5.0	.032
PE-53117	H330	330	3.0	200	292	0.15	KM-5.0	.025
PE-53118	H470	470	2.0	200	369	0.17	KM-5.0	.025
PE-53119	H680	680	1.3	200	562	0.20	KM-5.0	.025
PE-53120	H1000	1000	0.95	200	762	0.24	KM-5.0	.025
PE-53121	H1500	1500	0.62	200	1150	1.00	Case	.032
PE-53122	H220	2200	0.42	200	1730	1.80	Case	.032

NOTES:

1. Typical inductance occurs at the I_{DC} and ET_{OP} values shown.
2. The control value of inductance is measured at B_{OP} equal to or less than 10 gauss (10 mV @ 20 KHz) without DC current.
3. Inductance decreases with higher values of DC current and increases with lower values of DC current.
4. Inductance increases with increase in B_{OP} or ET_{OP}.
5. SIMPLE SWITCHER™ is a trademark of National Semiconductor Corporation.

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INDUCTORS DESIGNED FOR NATIONAL'S 50 KHz SIMPLE SWITCHER™

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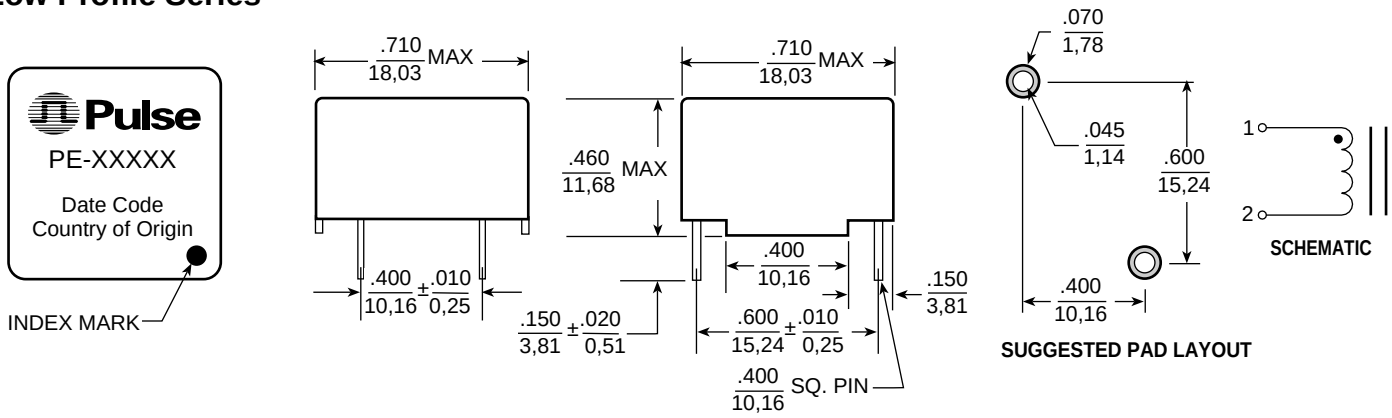
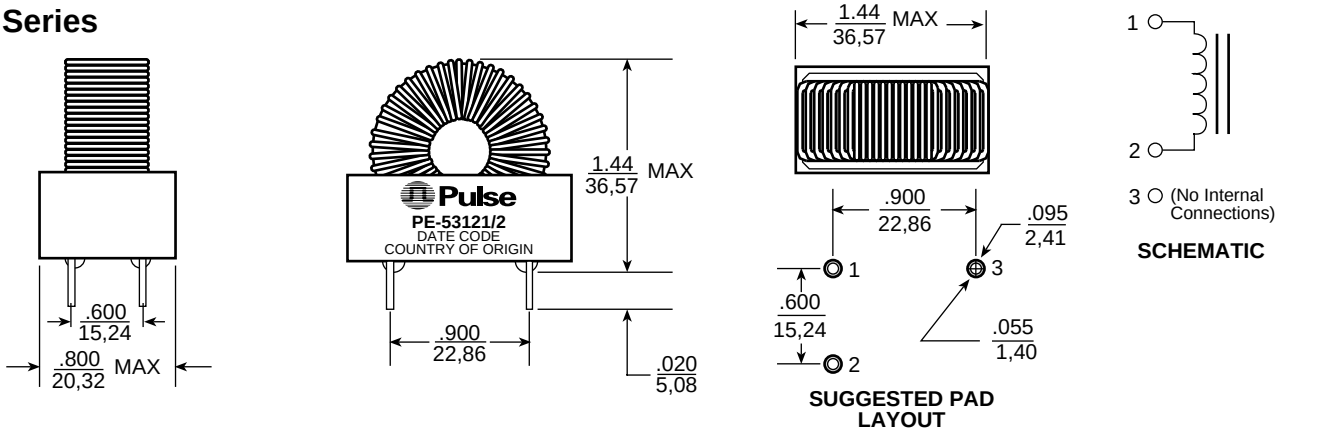
Mechanicals

Low Profile Series



Case Series

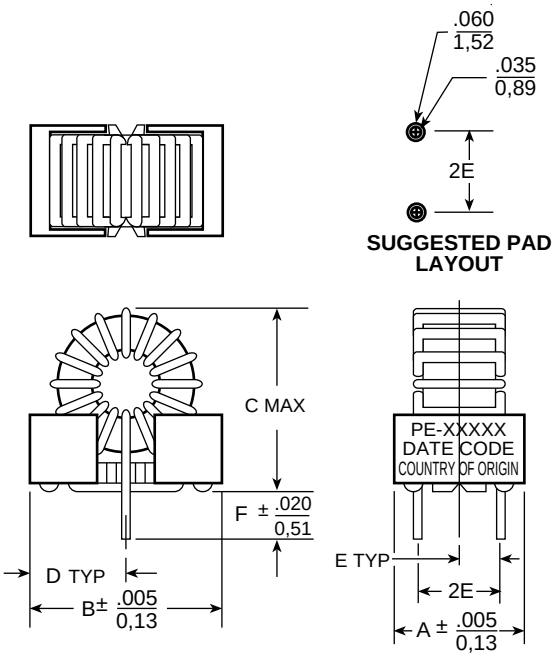


KlipMount Series

PKG	A	B	C	D	E	F
KM-2.0	.450 11,43	.650 16,51	.700 17,73	.325 8,26	.150 3,81	.130 3,30
KM-3.0	.450 11,43	.830 21,08	.950 24,13	.415 10,54	.150 3,81	.130 3,30
KM-4.0	.600 15,24	.950 24,13	1.00 25,4	.475 12,07	.225 5,72	.130 3,30
KM-5.0	.700 17,73	1.30 33,02	1.40 35,56	.625 15,88	.250 6,35	.130 3,30

Dimensions: Inches / mm

Unless otherwise specified, all tolerances are ± .010 / 0,25



INDUCTORS DESIGNED FOR NATIONAL'S 150 KHz SIMPLE SWITCHER™

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- Tested and recommended by National Semiconductor
- Base material meets flammability requirements of UL 94V-0
- Available in surface mount and through hole versions

Electrical Specifications @ 25°C— Operating Temperature -30° to +130° C

Pulse THT Part Number	Pulse SMT Part Number	National Part Number	In Circuit Operating Parameters[1]			Nominal DCR	Package	
			Nominal Inductance (µH)	Rated Current (Amps DC)	Max[2] ETOP (V-µSec)		Through Hole	Surface Mount
PE-53801	**PE-53801S**	LM259X-L1	259	0.13	23.1	3.4	LP-25	LCI-20
PE-53802	**PE-53802S**	LM259X-L2	178	0.16	16.5	2.8	LP-25	LCI-20
PE-53803	**PE-53803S**	LM259X-L3	118	0.2	13.2	1.8	LP-25	LCI-20
PE-53804	**PE-53804S**	LM259X-L4	79	0.25	9.9	1.5	LP-25	LCI-20
PE-53805	**PE-53805S**	LM259X-L5	55	0.3	6.6	1.0	LP-25	LCI-20
PE-53806	**PE-53806S**	LM259X-L6	39	0.34	6.6	.80	LP-25	LCI-20
PE-53807	**PE-53807S**	LM259X-L7	26	0.45	6.6	.62	LP-25	LCI-20
PE-53808	**PE-53808S**	LM259X-L8	374	0.2	75.9	2.7	LP-30	LCI-30
PE-53809	**PE-53809S**	LM259X-L9	256	0.25	33	2.2	LP-30	LCI-30
PE-53810	**PE-53810S**	LM259X-L10	176	0.3	26.4	1.4	LP-30	LCI-30
PE-53811	**PE-53811S**	LM259X-L11	118	0.38	19.8	1.2	LP-30	LCI-30
PE-53812	**PE-53812S**	LM259X-L12	78	0.46	16.5	0.8	LP-30	LCI-30
PE-53813	**PE-53813S**	LM259X-L13	55	0.56	13.2	0.5	LP-30	LCI-30
PE-53814	**PE-53814S**	LM259X-L14	39	0.68	9.9	0.3	LP-30	LCI-30
PE-53815	**PE-53815S**	LM259X-L15	26	0.84	6.6	0.2	LP-30	LCI-30
PE-53816	**PE-53816S**	LM259X-L16	17	1.02	6.6	0.1	LP-30	LCI-30
PE-53817	**PE-53817S**	LM259X-L17	375	0.36	75.9	1.3	LP-37	LCI-37
PE-53818	**PE-53818S**	LM259X-L18	252	0.44	49.5	0.9	LP-37	LCI-37
PE-53819	**PE-53819S**	LM259X-L19	173	0.54	36.3	0.6	LP-37	LCI-37
PE-53820	**PE-53820S**	LM259X-L20	115	0.67	29.7	0.4	LP-37	LCI-37
PE-53821	**PE-53821S**	LM259X-L21	78	0.82	23.1	0.3	LP-37	LCI-37
PE-53822	**PE-53822S**	LM259X-L22	54	1.0	16.5	0.2	LP-37	LCI-37
PE-53823	**PE-53823S**	LM259X-L23	38	1.2	13.2	0.1	LP-37	LCI-37
PE-53824	**PE-53824S**	LM259X-L24	26	1.48	9.9	0.1	LP-37	LCI-37
PE-53825	**PE-53825S**	LM259X-L25	18	1.81	9.9	0.06	LP-37	LCI-37
PE-53826	**PE-53826S**	LM259X-L26	377	0.68	75.9	1.0	LP-44	LCI-44
PE-53827	**PE-53827S**	LM259X-L27	248	0.83	72.6	0.6	LP-44	LCI-44
PE-53828	**PE-53828S**	LM259X-L28	168	1.02	56.1	0.4	LP-44	LCI-44
PE-53829	**PE-53829S**	LM259X-L29	112	1.26	42.9	0.3	LP-44	LCI-44
PE-53830	**PE-53830S**	LM259X-L30	77	1.54	33	0.2	LP-44	LCI-44
PE-53831	**PE-53831S**	LM259X-L31	53	1.87	26.4	0.13	LP-44	LCI-44
PE-53932	**PE-53932S**	LM259X-L32	37	2.24	19.8	0.10	LP-44	LCI-44
PE-53933	**PE-53933S**	LM259X-L33	24	2.74	16.5	0.07	LP-44	LCI-44
PE-53934	**PE-53934S**	LM259X-L34	17	3.0	13.2	0.05	KM-10	LCI-44
PE-53935	**PE-53935S**	LM259X-L35	250	1.5	72.6	0.23	KM-30	HCI-68
PE-54036	**PE-54036S**	LM259X-L36	168	1.81	75.9	0.18	KM-30	HCI-68
PE-54037	**PE-54037S**	LM259X-L37	114	2.22	62.7	0.10	KM-30	HCI-68
PE-54038	**PE-54038S**	LM259X-L38	77	2.7	52.8	0.09	KM-30	HCI-68
PE-54039	**PE-54039S**	LM259X-L39	53	3.0	42.9	0.08	KM-30	HCI-68
PE-54040	**PE-54040S**	LM259X-L40	38	3.0	29.7	0.05	KM-30	HCI-68
PE-54041	**PE-54041S**	LM259X-L41	25	3.0	19.8	0.04	KM-20	LCI-50
PE-54042	—	LM259X-L42	167	2.5	75.9	0.14	KM-40	—
PE-54043	—	LM259X-L43	110	3.0	75.9	0.09	KM-40	—
PE-54044	**PE-54044S**	LM259X-L44	77	3.0	59.4	0.08	KM-30	HCI-68
PE-53900	—	LM258X-L	19	4.5	32[3]	0.02	KM-30	—

Notes :
1. Inductance values may vary ±20%.
2. ETop rated at 150 KHz except where designated.
3. ETop rated at 100 KHz.
4. SIMPLE SWITCHER™ is a trademark of National Semiconductor Corporation.

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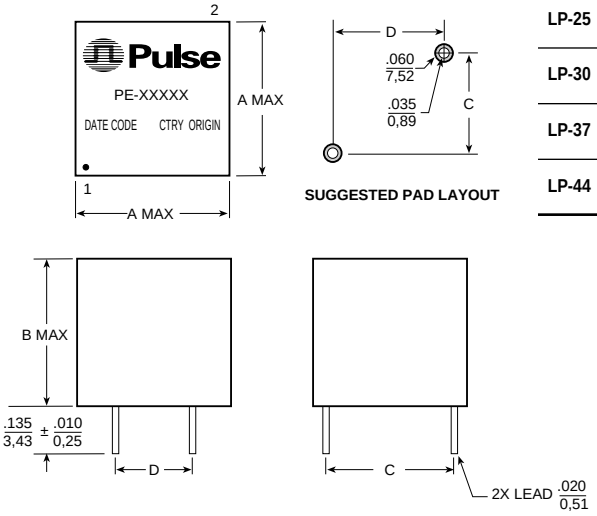
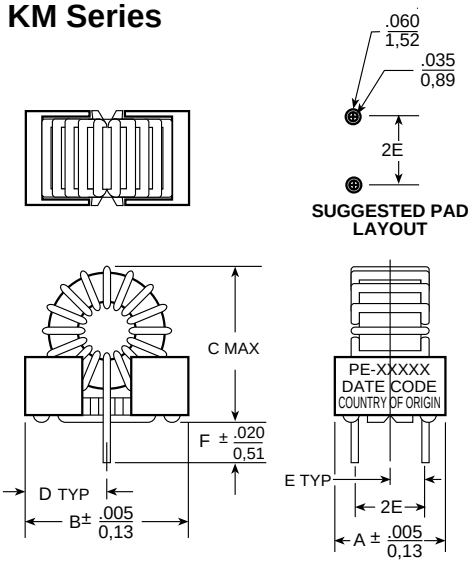
Mechanicals

LP Series



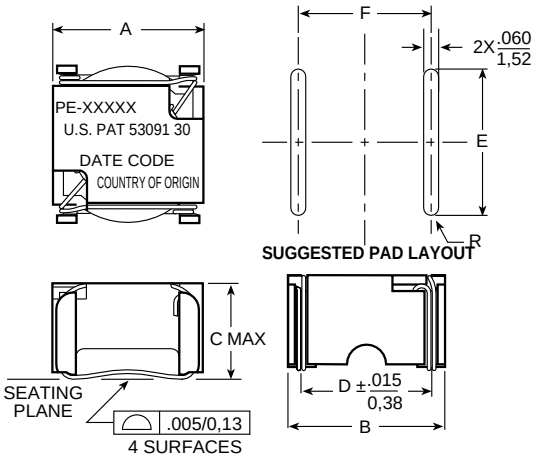
PKG	A	B	C	D
LP-25	.360 9,14	.310 7,87	.250 6,35	.250 6,35
LP-30	.400 10,16	.300 7,62	.300 7,62	.300 7,62
LP-37	.495 12,57	.375 9,52	.375 9,52	.375 9,52
LP-44	.635 16,13	.365 9,27	.500 12,7	.300 7,62

KM Series



PKG	A	B	C	D	E	F
KM-10	.340 8,64	.580 14,73	.650 16,51	.290 7,37	.110 2,79	.130 3,30
KM-20	.450 11,43	.650 16,51	.700 17,73	.325 8,26	.150 3,81	.130 3,30
KM-30	.450 11,43	830 21,08	.950 24,13	.415 10,54	.150 3,81	.130 3,30
KM-40	.600 15,24	.950 24,13	1.00 25,4	.475 12,07	.225 5,72	.130 3,30

LCI Series

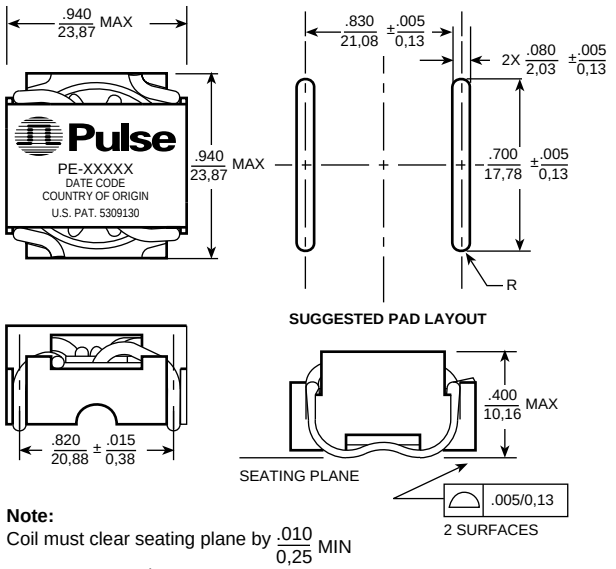


Notes:

1. Dimension "D" is measured across terminal blocks only.
2. Coil must clear seating plane by .010 0,25 MIN.

PKG	A	B	C	D	E	F
LCI-20	.340 8,64	.340 8,64	.270 6,86	.260 6,60	.300 7,62	.270 6,86
LCI-30	.435 11,05	.440 11,18	.360 9,14	.350 8,89	.400 10,16	.360 9,14
LCI-37	.565 14,35	.570 14,48	.360 9,14	.450 11,43	.520 13,21	.460 11,68
LCI-44	.600 15,24	.620 15,75	.390 9,91	.500 12,7	.550 13,97	.510 12,95
LCI-50	.670 17,02	.700 17,78	.390 9,91	.580 14,73	.620 15,75	.590 14,99

HCI-68



Note:
Coil must clear seating plane by .010 0,25 MIN

Dimensions: Inches / mm

Unless otherwise specified, all tolerances are ± .010 0,25

INDUCTORS
POWER MAGNETICS

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TABLE of CONTENTS

Miniature Surface Mount Power Inductors 2-3

Low Profile Self-Leaded Surface Mount Inductors
- Power Inductors with One Winding (up to 3.8 amp) 4
- Power Inductors with Two Windings (up to 8.3 amp) 5
- Power Inductors with .098" Height (up to 2.8 amp) 6

Surface Mount Inductors (SLIC)
- High and Low Current Coupled Inductors 7
- High and Low Current One-Winding Inductors 8-9

Inductors for National's Simple Switcher™
- 150 KHz Simple Switcher™ 10-11
- 50 KHz Simple Switcher™ 12-13

Inductor for Harris Semiconductor™
- HIP 5020 14

PGF Inductors 15

Current Sense Inductors and Transformers
- Low Profile Self-Leaded Surface Mount 16
- Through Hole, VDE Approved 17
- 500 KHz Through Hole 18

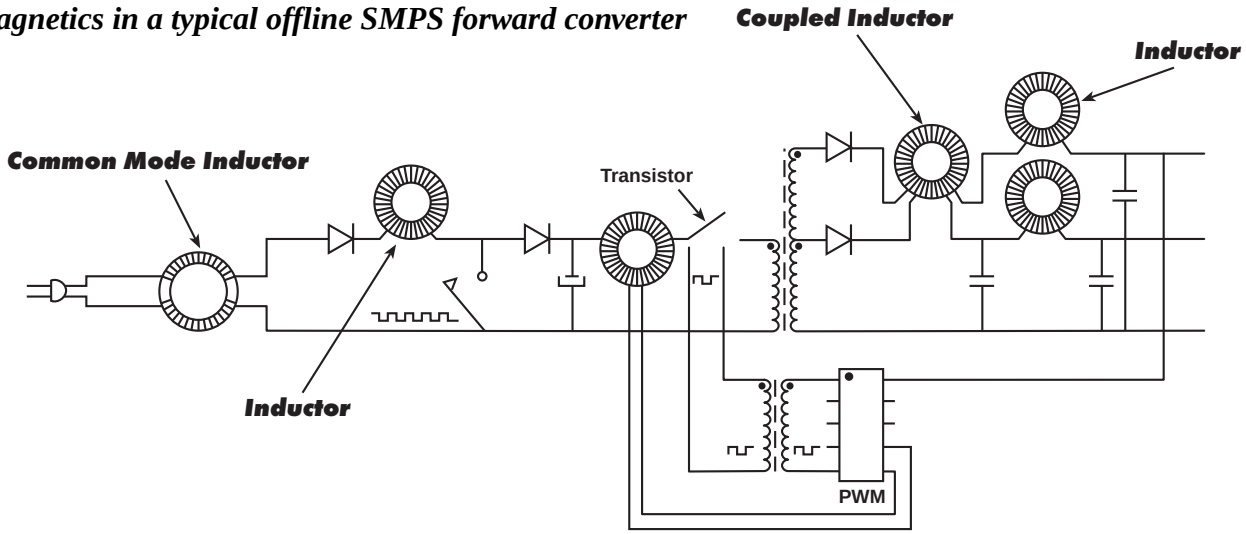
Standard Low Power Inductors 19

Low Cost Inductors 20-21

Toroidal Inductors
- High Current 22
- High Inductance 23

Common Mode Inductors
- EMI Suppression 24
- 500 KHz EMI 25

Magnetics in a typical offline SMPS forward converter



MINIATURE SURFACE MOUNT POWER INDUCTORS

Pulse
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- Reliable self-leads
- Very small size and cost-effective
- High energy storage and low DC resistance
- Ideal for DC/DC conversion in notebook computers, PDAs, step-up or step-down converters

Electrical Specifications @ 25°C — Operating Temperature -30°C to +130°C

Pulse Part Number	Reference Values			Control Values		Calculation Data	CoilCraft Part Number
	I_{DC} (amp)	L @ I_{DC} ±15% (µH)	ET (V-µsec)	L w/o DC ±15% (µH)	DCR ±15% (mΩ)	ET_{10} (V-µsec)	
ROS 1							
P0430T	2.00	0.6	0.8	0.7	14	476.2	DT1608C-102
P0431T	1.90	0.9	0.8	1.1	18	370.4	DT1608C-152
P0432T	1.50	1.0	1.2	1.1	18	370.4	DT1608C-222
P0433T	1.20	1.7	1.8	1.9	28	277.8	DT1608C-332
P0434T	1.20	2.2	1.8	2.6	34	238.1	DT1608C-472
P0435T	1.00	3.2	2.3	3.9	40	196.1	DT1608C-682
P0436T	0.70	5.1	3.1	6.0	73	158.7	DT1608C-103
P0437T	0.60	6.3	3.3	7.1	100	144.9	DT1608C-153
P0438T	0.50	10.4	4.4	12.2	140	111.1	DT1608C-223
P0439T	0.45	12.7	5.0	14.7	155	101.0	DT1608C-333
P0440T	0.34	20.7	6.5	23.8	250	79.4	DT1608C-473
P0441T	0.29	30	8.4	33.8	280	66.7	DT1608C-683
P0442T	0.24	42.2	9.8	49	440	55.6	DT1608C-194
P0443T	0.20	62	12	72	650	45.7	DT1608C-154
P0444T	0.17	93	14	110	1050	37.0	DT1608C-224
P0445T	0.16	104	15	122	1065	35.1	DT1608C-334
P0446T	0.14	150	18	179	1600	29.0	DT1608C-474
ROS 2							
P0450T	5	0.6	3.0	0.64	7.6	181.8	DT3316P-102
P0451T	5	0.79	3.1	0.86	8.7	151.5	DT3316P-152
P0452T	5	1.29	0.5	1.5	11.4	113.6	DT3316P-222
P0453T	5	1.8	1.0	2.3	13	90.9	DT3316P-332
P0454T	3	2.1	7.5	2.3	13	90.9	DT3316P-472
P0455T	2.5	4.4	10.5	5.13	23	60.6	DT3316P-682
P0456T	2	5.6	13	6.3	26	56.8	DT3316P-103
P0457T	1.8	6.6	14	7.5	33	50.5	DT3316P-153
P0458T	1.5	10.7	15	13.2	70	39.5	DT3316P-223
P0459T	1.3	13.5	21	15.5	60	35.0	DT3316P-333
P0460T	1	27	31	34	90	24.6	DT3316P-473
P0461T	0.9	46	39	57.2	123	18.9	DT3316P-683
P0462T	0.8	48	35	62.5	240	18.2	DT3316P-194
P0463T	0.6	82	55	100	245	14.0	DT3316P-154
P0464T	0.5	90	54	103	305	14.2	DT3316P-224
P0465T	0.4	162	78	180	481	10.0	DT3316P-334
P0466T	0.35	215	87	254	682	8.7	DT3316P-474
P0467T	0.3	320	105	380	1030	7.0	DT3316P-684
P0468T	0.25	420	130	500	1200	6.1	DT3316P-105

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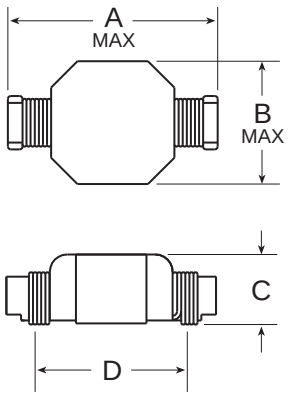
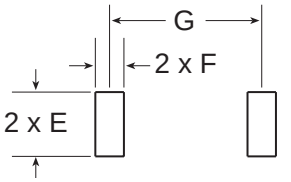
MINIATURE SURFACE MOUNT POWER INDUCTORS

Notes:

1. Temperature rise is 55° C in typical buck or boost circuits with the rated I_{DC} current and reference ET applied to the inductor.
2. Total loss in the inductor is 80 mWatts (ROS 1) and 280 mWatts (ROS 2) for 55°C temperature rise above ambient.
3. To estimate temperature rise in a given application, you must determine the total losses (copper losses + core losses) and apply the following formula:
   ROS 1: TempRise (C) = (Total Losses (mW))$^{.833}$ x 1.45
   ROS 2: TempRise (C) = (Total Losses (mW))$^{.833}$ x .508
4. To determine copper losses, calculate:
   CopperLoss (mW) = I_{DC}^2 x DCR
5. For core loss in mWatts, using frequency f (in Hz) and operating flux density B (in Gauss), calculate:
   ROS 1: CopperLoss (mW) = .127 x 10^{-10} x $f^{1.26}$ x $B^{2.11}$
   ROS 2: CopperLoss (mW) = .887 x 10^{-10} x $f^{1.26}$ x $B^{2.11}$
6. For flux density (B), calculate ET (V-µsec) for the application, and multiply by ET_{10} factor from the table.

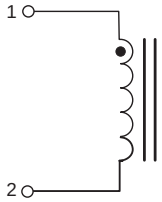
Mechanical





Suggested Pad Layout

Schematic



Dimensions: Inches / mm

Unless otherwise specified, all tolerances are ± .010 / 0,25

PKG	A	B	C	D	E	F	G
ROS 1	.360 9,14	.210 5,33	.125 3,18	.260 6,60	.110 2,79	.050 1,27	.260 6,60
ROS 2	.550 13,97	.400 10,16	.210 5,33	.400 10,16	.115 2.92	.060 1,52	.439 11,15

	ROS 1	ROS 2
Weight	0.29 grams	1.1 grams
Tape & Reel	2000/reel	600/reel

LOW PROFILE SELF-LEADED SURFACE MOUNT INDUCTORS

Pulse
A TECHNITROL COMPANY

NEW!

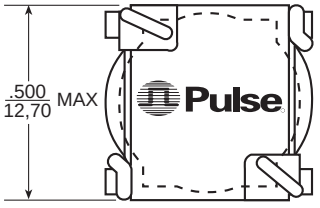
- Materials meet UL94V-0 rating
- Suited for IR and vapor reflow solder
- Fits in half inch high boards for use in lap-top and notebook computers
- Frequency range of up to 1 MHz
- Patented, low profile, self-leaded design

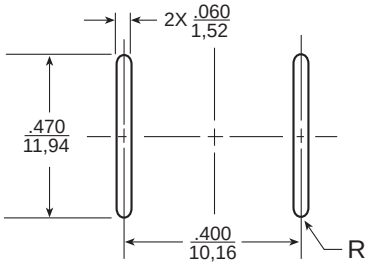
Electrical Specifications @ 25°C — Operating Temperature -30°C to +130°C

Part Number	Reference Values				Control Values		Calculation Data	
	I_{DC} (amp)	L @ DC L_{DC} (µH)	ET (V-µsec)	Storage Capacity (µJ)	L w/o DC L_0 ±20% (µH)	DCR MAX (mΩ)	100 Gauss ET_{100} (V-µsec)	1 Amp DC H_1 (Orsted)
P0153	0.53	439	1.3	61.6	472	1520	17.83	80.37
P0152	0.65	305	1.6	64.4	331	972	14.94	67.34
P0151	0.81	200	1.9	65.6	220	673	12.17	54.85
P0150	0.99	137	2.4	67.0	152	425	10.12	45.61
P0149	1.23	90	3.0	67.8	100	285	8.19	36.93
P0148	1.35	75	3.2	67.9	83	220	7.47	33.67
P0147	1.65	50	4.0	68.6	56	135	6.15	27.69
P0146	2.43	23	5.8	66.9	25	74	4.10	18.46
P0145	3.13	13.3	7.5	64.9	14.6	46	3.13	14.12
P0144	3.80	9.4	9.1	67.7	10.4	32	2.65	11.95

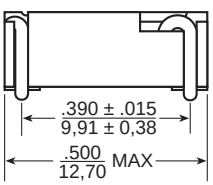
Notes:
1. The reference inductance is a typical value at the AC and DC excitation listed.
2. Temperature rise is 50°C in typical buck or boost circuits at 250 KHz and with the reference ET applied to the inductor.
3. Total loss in the inductor is 380 mWatts for 50°C temperature rise above ambient.
4. To estimate temperature rise in a given application, determine copper and core losses, divide by 380 and multiply by 50.
5. For the copper loss (mW), calculate $I_{DC}^2 \times R_N$ with R_N in mΩ.
6. The maximum DCR listed is approximately 17% over the nominal DCR ($R_{N)}$.
7. For core loss (mW), using frequency (f, Hertz) and operating flux density (B, Gauss), calculate $6.11 \times 10^{-18} \times B^{2.7} \times f^{2.04}$.
8. For flux density (B, Gauss), calculate ET (V-µsec) for the application, divide by ET_{100} from the table, and multiply by 100.
9. Limit the DC bias (H) to 46 Orsteds. Calculate H (Orsted) by multiplying H_1 from the table by I_{DC} of the application.

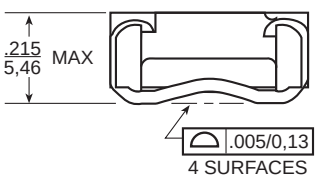
Mechanical



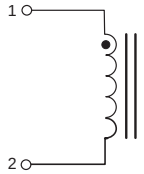


Suggested Pad Layout





Schematic



Weight . . . . . .1.5 grams
Tape & Reel 500/reel
Tube 40/tube

Dimensions: Inches / mm

Unless otherwise specified all tolerances are ± .010 / 0,25

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LOW PROFILE SELF-LEADED SMT DUAL INDUCTORS

Pulse
A TECHNITROL COMPANY

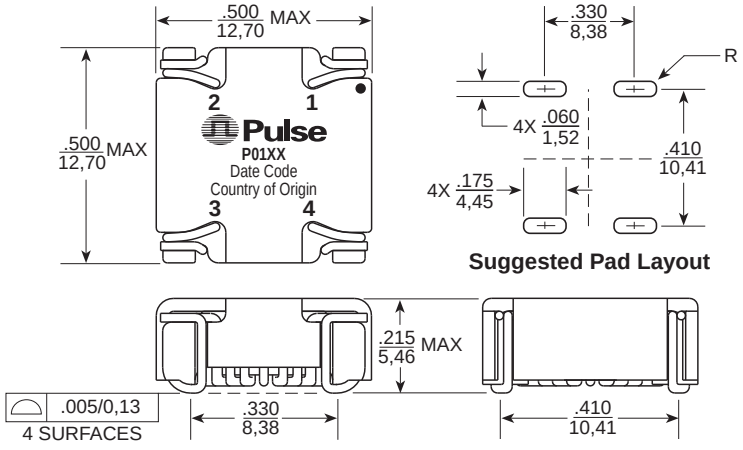
- Materials meet UL94V-0 rating
- Suited for IR and vapor reflow solder
- Frequency range of up to 1 MHz
- Can be used as a simple inductor, 1:1 coupled inductor, or 1:1 transformer

Electrical Specifications @ 25°C — Operating Temperature -30°C to +130°C

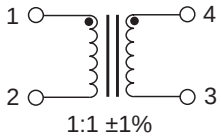
ID		Reference Values			Control Values		Calculation Data	
Part Number	Hookup	I_{DC} (amp)	L @ DC L_{DC} (µH)	ET (V-µsec)	L w/o DC L_0 ±20% (µH)	DCR (MAX) (mΩ)	100 Gauss ET_{100} (V-µsec)	1 Amp DC H_1 (Orsted)
P0183	Series	0.61	336.7	92.43	364.0	1295	15.66	70.59
P0182	Series	0.74	245.3	81.70	270.2	897	13.50	60.82
P0181	Series	0.90	170.3	68.99	190.3	603	11.33	51.05
P0180	Series	1.08	117.3	57.00	131.0	424	9.40	42.36
P0183	Parallel	1.22	84.2	46.22	91.0	324	7.83	35.30
P0179	Series	1.32	79.0	46.90	88.2	265	7.71	34.75
P0182	Parallel	1.48	61.3	40.85	67.5	224	6.75	30.41
P0178	Series	1.56	56.2	39.46	62.8	181	6.51	29.32
P0181	Parallel	1.80	42.6	34.49	47.6	151	5.66	25.52
P0177	Series	1.92	37.3	32.25	41.7	119	5.30	23.89
P0180	Parallel	2.16	29.3	28.50	32.8	106	4.70	21.18
P0176	Series	2.60	20.0	23.43	22.1	76.0	3.86	17.38
P0179	Parallel	2.64	19.7	23.45	22.1	66.3	3.86	17.38
P0178	Parallel	3.12	14.1	19.73	15.7	45.3	3.25	14.66
P0175	Series	3.60	9.6	15.62	10.4	43.6	2.65	11.95
P0177	Parallel	3.84	9.3	16.12	10.4	29.8	2.65	11.95
P0174	Series	4.15	7.8	14.61	8.6	30.3	2.41	10.86
P0176	Parallel	5.20	5.0	11.72	5.5	19.0	1.93	8.69
P0175	Parallel	7.20	2.4	7.81	2.6	10.9	1.33	5.97
P0174	Parallel	8.30	2.0	7.31	2.2	7.6	1.20	5.43

NOTES:
1. The reference inductance at rated DC current is a typical value.
2. Temperature rise is 50°C in typical buck or boost circuits at 250 KHz and with the reference ET applied to the inductor.
3. Total loss in the inductor is 380 mWatts for a 50°C temperature rise above ambient.
4. To estimate temperature rise in a given application, determine copper and core losses, divide by 380 and multiply by 50.
5. For the copper loss, calculate $I_{DC}{}^2 X R_N$.
6. For core loss, using frequency (f) and operating flux density (B), calculate $6.11 \times 10^{-18} \times B^{2.7} \times f^{2.04}$.
7. For flux density (B), calculate ET (V-µsec) for the application, divide by ET_{100} from the table, and multiply by 100.
8. Limit the DC bias (H) to 46 orsteds. Calculate H by multiplying H_1 from the table by I_{DC} of the application.
9. The maximum DCR listed is approximately 17% over the nominal DCR.
10. Add suffix **"T"** to part number for tape and reel package (i.e. P0183**T**).

Mechanical



Schematic



Weight . . . . . 1.5 grams
Tape & Reel 500/reel
Tube 40/tube

Dimensions: Inches / mm

Unless otherwise specified, all tolerances are ± .010 / 0,25

LOW PROFILE SELF-LEADED POWER INDUCTORS

Designed for PCMCIA Applications

Pulse
A TECHNITROL COMPANY

NEW!

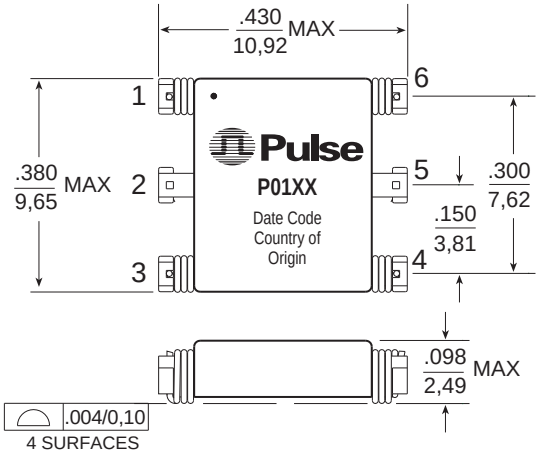
- Small PCMCIA size (.38" X .43" X .098")
- Frequency range: 100 KHz to 1 MHz
- Up to 3 amps rated DC current
- Surface mount, pick and placeable

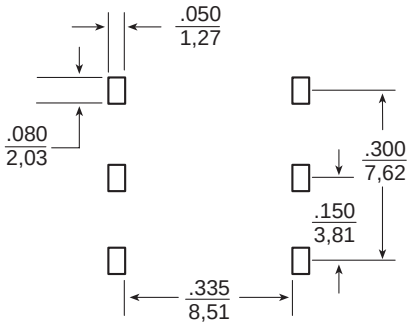
Electrical Specifications @ 25°C — Operating Temperature -30°C to +130°C

ID		Reference Values			Control Values		Calculation Data	
Part Number	Hookup	I_{DC} (amp)	L @ DC L_{DC} (µH)	ET (V-µsec)	L w/o DC L_0 ±20% (µH)	DCR (MAX) (mΩ)	100 Gauss ET_{100} (V-µsec)	1 Amp DC H_1 (Orsted)
P0108	Series	0.27	122.6	16.55	137.8	1545	2.77	102.50
P0107	Series	0.33	88.5	14.60	100.5	1068	2.37	87.55
P0106	Series	0.40	60.1	12.03	69.1	720	1.96	72.60
P0116	Series	0.44	43.6	9.59	46.9	692	1.62	59.79
P0108	Parallel	0.54	30.7	8.28	34.4	382	1.38	51.25
P0105	Series	0.62	20.1	6.22	21.6	325	1.10	40.57
P0107	Parallel	0.66	22.1	7.30	25.1	267	1.18	43.77
P0104	Series	0.73	15.7	5.74	17.3	236	0.98	36.30
P0106	Parallel	0.80	15.0	6.01	17.3	180	0.98	36.30
P0103	Series	0.86	12.1	5.21	13.5	170	0.87	32.03
P0116	Parallel	0.88	10.9	4.80	11.7	173	0.81	29.89
P0102	Series	1.03	9.0	4.63	10.1	121	0.75	27.76
P0101	Series	1.23	6.4	3.92	7.2	86	0.63	23.49
P0105	Parallel	1.24	5.0	3.11	5.4	81	0.55	20.29
P0100	Series	1.41	5.2	3.67	6.0	66	0.58	21.35
P0104	Parallel	1.46	3.9	2.87	4.3	59	0.49	18.15
P0103	Parallel	1.72	3.0	2.60	3.4	42	0.43	16.01
P0102	Parallel	2.06	2.2	2.32	2.5	30	0.38	13.88
P0101	Parallel	2.46	1.6	1.96	1.8	22	0.32	11.74
P0100	Parallel	2.82	1.3	1.83	1.5	16	0.29	10.68

NOTES:
1. The reference inductance at rated DC current is a typical value.
2. Temperature rise is 50°C in typical buck or boost circuits at 500 KHz and with the reference ET applied to the inductor.
3. Total loss in the inductor is 95 mWatts for 50°C temperature rise above ambient.
4. To estimate temperature rise in a given application, determine copper and core losses, divide by 95 and multiply by 50.
5. For the copper loss, calculate $I_{DC}{}^2 X R_N$.
6. For R_N, multiply DCR_{MAX} by 0.85.
7. For core loss, using frequency (f) and operating flux density (B), calculate $747 \times 10^{-21} \times B^{2.7} \times f^{2.04}$.
8. For flux density (B), calculate ET (V-µsec) for the application, divide by ET_{100} from the table, and multiply by 100.
9. Limit the DC bias (H) to 31 orsteds. Calculate H by multiplying H_1 from the table by I_{DC} of the application.
10. Add suffix **"T"** to part number for tape and reel package (i.e. P0100**T**).

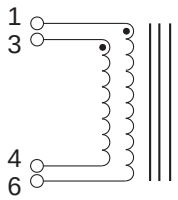
Mechanical





SUGGESTED PAD LAYOUT

Schematic



Weight.....0.25 grams
Tape & Reel.....1250/reel
Tube.....55/tube

Dimensions: Inches / mm

Unless otherwise specified, all tolerances are ± .010 / 0,25

HIGH AND LOW CURRENT COUPLED INDUCTORS

Pulse
A TECHNITROL COMPANY

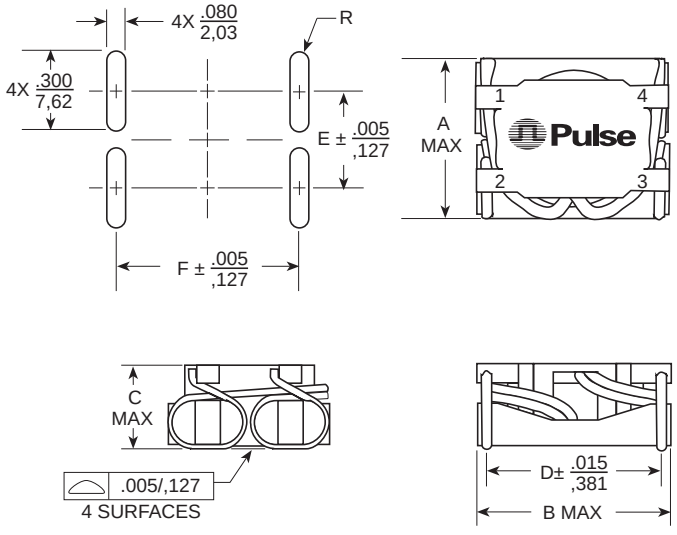
- Self-leaded, surface mount
- Suited for IR and vapor phase reflow soldering
- Frequency range up to 1 MHz

Electrical Specifications @ 25°C — Operating Temperature -30°C to 130°C

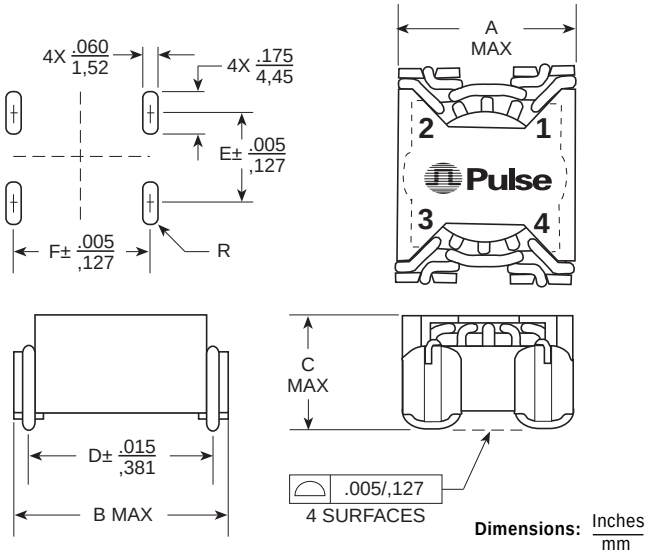
Part Number	I_{DC} (Amps)	$L_{W/DC}$ (µH)	ET (V-µ sec)	Size Code	$L_{W/oDC}$ (µH ± 20%)	Max DCR (mΩ)
PE-53361	23.8	.53	1.00	HCCI-44	.88	1.7
PE-53362	21.0	1.10	1.75	HCCI-50	2.10	3.0
PE-53363	22.4	2.10	3.25	HCCI-68	4.00	3.4
PE-53717	1.1	43.6	7.83	LCCI-37	77.0	309
PE-53718	2.7	21.9	6.90	LCCI-44	39.5	90.5
PE-53719	6.4	4.025	3.135	LCCI-50	6.575	23

Mechanicals

HCCI



LCCI



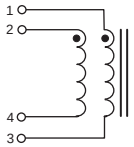
Dimensions: Inches / mm

Size Codes

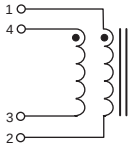
	HCCI-44	HCCI-50	HCCI-68	LCCI-37	LCCI-44	LCCI-50
A	.715/18,16	.800/20,32	1.000/25,40	.560/14,22	.590/14,99	.670/17,02
B	.865/21,97	.910/23,11	1.110/28,19	.645/16,38	.715/18,16	.770/19,56
C	.390/9,91	.390/9,91	.390/9,91	.350/8,89	.390/9,91	.390/9,91
D	.760/10,30	.800/20,32	1.000/25,40	.520/13,21	.600/15,24	.650/16,51
E	.360/9,14	.440/11,18	.620/15,75	.340/8,64	.370/9,40	.445/11,30
F	.770/19,56	.810/20,57	1.010/25,65	.530/13,46	.610/15,49	.660/16,76

Schematics

HCCI



LCCI



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SURFACE MOUNT INDUCTORS SELF-LEADED

Electrical Information

- Materials meet UL94V-0 rating
- Suited for IR and vapor reflow solder
- Fits in half inch high boards for use in lap-top and notebook computers
- Frequency range of up to 1 MHz
- Patented, low profile, self-leaded design

Electrical Specifications @ 25°C — Operating Temperature -30°C to +130°C

Reference Values[1]				Control Values			Calculation Data		
Pulse Part Number	I_{DC}[2] (Amps)	L with DC L_{DC} (µH)	ET	Size Code	L w/o DC L_O (µH ± 20%)	DCR R_{DC} (mΩ MAX)	100 Gauss ET_{100} (V-µSec)	1 Amp DC H_I (Orsted)	DCR R_N (mΩ NOM)
PE-53600	1.40	6.20	1.33	LCI-20	7.0	70.0	0.94	21.9	60.3
PE-53601	1.00	17.6	2.40	LCI-20	22.7	125	1.68	39.3	109
PE-53602	1.40	29.7	4.60	LCI-30	35.3	166	4.12	23.2	141
PE-53604	1.30	58.1	7.83	LCI-37	73.0	290	7.09	28.8	233
PE-53606	0.94	114	10.0	LCI-30	167	380	8.97	50.5	330
PE-53608	0.90	192	15.7	LCI-37	292	560	14.2	57.7	472
PE-53611	0.72	383	23.5	LCI-37	672	862	21.3	86.5	750
PE-53613	0.74	645	36.5	LCI-44	1134	1250	37.2	84.4	1040
PE-53614	0.71	1070	54.4	LCI-50	1950	1700	56.9	95.7	1480
PE-53630	3.4	1.01	0.532	LCI-20	1.10	11.0	0.37	8.74	12.5
PE-53631	2.8	9.4	2.70	LCI-30	12.3	43.4	2.42	13.7	37.8
PE-53632	2.7	16.2	4.29	LCI-37	21.9	63.0	3.88	15.8	54.7
PE-53633	2.7	29.1	6.90	LCI-44	40.5	85.0	7.02	15.9	75.8
PE-53634	2.6	50.0	10.5	LCI-50	72.9	133	11.0	18.5	115
PE-53650	4.8	3.8	1.76	LCI-30	5.20	17.3	1.58	8.87	14.8
PE-53651	5.4	5.1	2.51	LCI-37	7.5	17.7	2.27	9.25	14.3
PE-53652	5.5	9.0	4.06	LCI-44	14.0	22.3	4.13	9.38	19.3
PE-53653	5.1	16.1	6.27	LCI-50	25.9	32.0	6.55	11.0	30.3
PE-53661	8.0	2.5	1.77	LCI-37	3.80	8.3	1.61	6.53	7.20
PE-53662	7.8	4.9	3.04	LCI-44	7.9	12.4	3.10	7.03	10.5
PE-53663	7.2	9.3	4.92	LCI-50	16.0	18.7	5.15	8.67	16.3
PE-53680	11.5	1.32	1.33	HCI-37	2.10	4.0	1.20	4.90	3.39
PE-53681	11.4	2.5	2.23	HCI-44	4.20	5.4	2.27	5.16	4.64
PE-53682	10.4	4.7	3.58	HCI-50	8.4	8.3	3.75	6.30	7.18
PE-53683	10.9	9.4	6.84	HCI-68	17.6	12.3	7.93	6.24	10.7
PE-53690	14.3	0.81	1.035	HCI-37*	1.25	2.5	0.94	381	2.16
PE-53691	13.9	1.68	1.83	HCI-44*	2.80	3.6	1.86	4.22	3.16
PE-53692	12.4	3.5	3.13	HCI-50*	6.5	6.6	3.28	5.52	5.75
PE-53700	15.4	5.2	5.21	HCI-68*	10.5	6.2	6.04	4.75	5.30

NOTES:

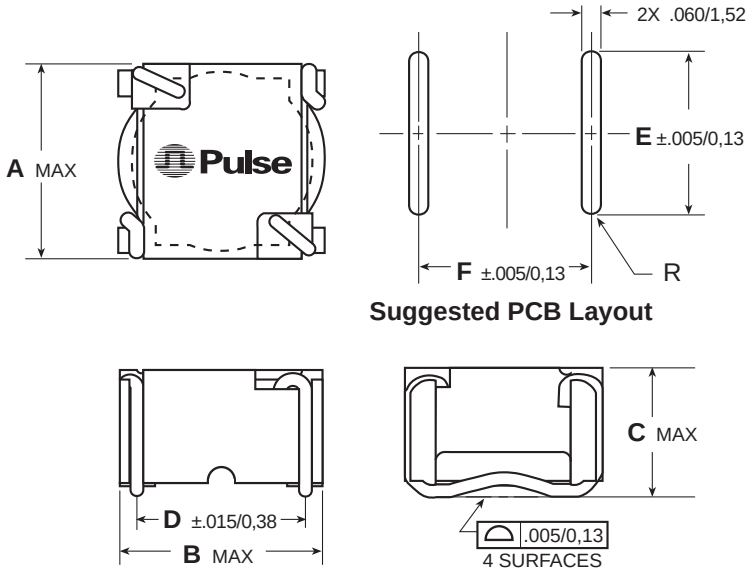
1. Reference values are for an inductor with a 55°C temperature rise. The core loss is 10% of the copper loss at the ET listed and 500 KHz.
2. Core does not saturate abruptly. The ET and DC current are limited by the desired inductance and temperature rise.
3. The temperature rise is directly proportional to the total watts loss (I^2R plus core loss). The core loss (mW/cc) equals $9.07 \times 10^{-10} f^{1.26} B^{2.11}$. B is the operating flux density (Gauss) due to ripple voltage and f is the operating frequency (Hertz) of the ripple current.
4. Standard packaging is in tubes. Optional 13" Tape & Reel packaging can be ordered by adding a "T" suffix to the part number, (i.e. PE-53600**T**).

SURFACE MOUNT INDUCTORS
SELF-LEADED

Mechanical Information

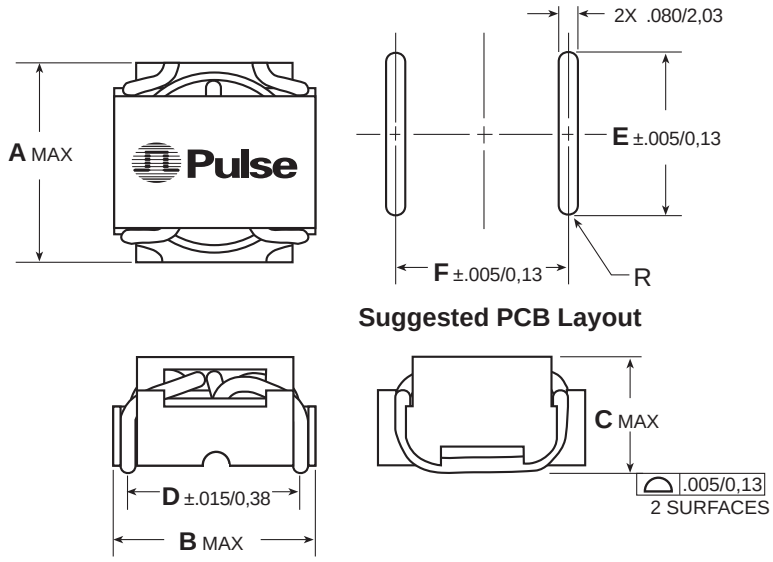
Mechanicals

Low Current Inductors (LCI)



PKG	A	B	C	D	E	F
LCI-20	.340 8,64	.340 8,64	.270 6,86	.260 6,60	.300 7,62	.270 6,86
LCI-30	.435 11,05	.440 11,18	.360 9,14	.350 8,89	.400 10,16	.360 9,14
LCI-37	.560 14,22	.565 14,35	.360 9,14	.450 11,43	.520 13,21	.460 11,68
LCI-44	.590 14,99	.615 15,62	.390 9,91	.500 12,70	.550 13,97	.510 12,95
LCI-50	.670 17,02	.700 17,78	.390 9,91	.580 14,73	.620 15,75	.590 14,99

High Current Inductors (HCI)



PKG	A	B	C	D	E	F
HCI-37	.615 15,62	.600 15,24	.370 9,40	.500 12,70	.440 11,18	.500 12,70
HCI-44	.665 16,89	.665 16,89	.390* 9,91	.560 14,22	.490 12,45	.570 14,48
HCI-50	.740 18,80	.740 18,80	.390* 9,91	.630 16,00	.560 14,22	.640 16,26
HCI-68	.940 23,88	.940 23,88	.390* 9,91	.820 20,83	.700 17,78	.830 21,08

* Dimension “C” is .400/10,16 for the marked models because of heavier wire gage.

Dimensions: Inches / mm

Unless otherwise specified, all tolerances are ± .010 / 0,25

INDUCTORS DESIGNED FOR NATIONAL'S 150 KHz SIMPLE SWITCHER™

Pulse
A TECHNITROL COMPANY

- Tested and recommended by National Semiconductor
- Base material meets flammability requirements of UL 94V-0
- Available in surface mount and through hole versions

Electrical Specifications @ 25°C— Operating Temperature -30° to +130° C

Pulse THT Part Number	Pulse SMT Part Number	National Part Number	In Circuit Operating Parameters[1]			Nominal DCR (Ω)	Package	
			Nominal Inductance (µH)	Rated Current (Amps DC)	Max[2] ETOP (V-µSec)		Through Hole	Surface Mount
PE-53801	**PE-53801S**	LM259X-L1	259	0.13	23.1	3.4	LP-25	LCI-20
PE-53802	**PE-53802S**	LM259X-L2	178	0.16	16.5	2.8	LP-25	LCI-20
PE-53803	**PE-53803S**	LM259X-L3	118	0.2	13.2	1.8	LP-25	LCI-20
PE-53804	**PE-53804S**	LM259X-L4	79	0.25	9.9	1.5	LP-25	LCI-20
PE-53805	**PE-53805S**	LM259X-L5	55	0.3	6.6	1.0	LP-25	LCI-20
PE-53806	**PE-53806S**	LM259X-L6	39	0.34	6.6	.80	LP-25	LCI-20
PE-53807	**PE-53807S**	LM259X-L7	26	0.45	6.6	.62	LP-25	LCI-20
PE-53808	**PE-53808S**	LM259X-L8	374	0.2	75.9	2.7	LP-30	LCI-30
PE-53809	**PE-53809S**	LM259X-L9	256	0.25	33	2.2	LP-30	LCI-30
PE-53810	**PE-53810S**	LM259X-L10	176	0.3	26.4	1.4	LP-30	LCI-30
PE-53811	**PE-53811S**	LM259X-L11	118	0.38	19.8	1.2	LP-30	LCI-30
PE-53812	**PE-53812S**	LM259X-L12	78	0.46	16.5	0.8	LP-30	LCI-30
PE-53813	**PE-53813S**	LM259X-L13	55	0.56	13.2	0.5	LP-30	LCI-30
PE-53814	**PE-53814S**	LM259X-L14	39	0.68	9.9	0.3	LP-30	LCI-30
PE-53815	**PE-53815S**	LM259X-L15	26	0.84	6.6	0.2	LP-30	LCI-30
PE-53816	**PE-53816S**	LM259X-L16	17	1.02	6.6	0.1	LP-30	LCI-30
PE-53817	**PE-53817S**	LM259X-L17	375	0.36	75.9	1.3	LP-37	LCI-37
PE-53818	**PE-53818S**	LM259X-L18	252	0.44	49.5	0.9	LP-37	LCI-37
PE-53819	**PE-53819S**	LM259X-L19	173	0.54	36.3	0.6	LP-37	LCI-37
PE-53820	**PE-53820S**	LM259X-L20	115	0.67	29.7	0.4	LP-37	LCI-37
PE-53821	**PE-53821S**	LM259X-L21	78	0.82	23.1	0.3	LP-37	LCI-37
PE-53822	**PE-53822S**	LM259X-L22	54	1.0	16.5	0.2	LP-37	LCI-37
PE-53823	**PE-53823S**	LM259X-L23	38	1.2	13.2	0.1	LP-37	LCI-37
PE-53824	**PE-53824S**	LM259X-L24	26	1.48	9.9	0.1	LP-37	LCI-37
PE-53825	**PE-53825S**	LM259X-L25	18	1.81	9.9	0.06	LP-37	LCI-37
PE-53826	**PE-53826S**	LM259X-L26	377	0.68	75.9	1.0	LP-44	LCI-44
PE-53827	**PE-53827S**	LM259X-L27	248	0.83	72.6	0.6	LP-44	LCI-44
PE-53828	**PE-53828S**	LM259X-L28	168	1.02	56.1	0.4	LP-44	LCI-44
PE-53829	**PE-53829S**	LM259X-L29	112	1.26	42.9	0.3	LP-44	LCI-44
PE-53830	**PE-53830S**	LM259X-L30	77	1.54	33	0.2	LP-44	LCI-44
PE-53831	**PE-53831S**	LM259X-L31	53	1.87	26.4	0.13	LP-44	LCI-44
PE-53932	**PE-53932S**	LM259X-L32	37	2.24	19.8	0.10	LP-44	LCI-44
PE-53933	**PE-53933S**	LM259X-L33	24	2.74	16.5	0.07	LP-44	LCI-44
PE-53934	**PE-53934S**	LM259X-L34	17	3.0	13.2	0.05	KM-10	LCI-44
PE-53935	**PE-53935S**	LM259X-L35	250	1.5	72.6	0.23	KM-30	HCI-68
PE-54036	**PE-54036S**	LM259X-L36	168	1.81	75.9	0.18	KM-30	HCI-68
PE-54037	**PE-54037S**	LM259X-L37	114	2.22	62.7	0.10	KM-30	HCI-68
PE-54038	**PE-54038S**	LM259X-L38	77	2.7	52.8	0.09	KM-30	HCI-68
PE-54039	**PE-54039S**	LM259X-L39	53	3.0	42.9	0.08	KM-30	HCI-68
PE-54040	**PE-54040S**	LM259X-L40	38	3.0	29.7	0.05	KM-30	HCI-68
PE-54041	**PE-54041S**	LM259X-L41	25	3.0	19.8	0.04	KM-20	LCI-50
PE-54042	—	LM259X-L42	167	2.5	75.9	0.14	KM-40	—
PE-54043	—	LM259X-L43	110	3.0	75.9	0.09	KM-40	—
PE-54044	**PE-54044S**	LM259X-L44	77	3.0	59.4	0.08	KM-30	HCI-68
PE-53900	—	LM258X-L	19	4.5	32[3]	0.02	KM-30	—

Notes :
1. Inductance values may vary ±20%.
2. ETop rated at 150 KHz except where designated.
3. ETop rated at 100 KHz.
4. SIMPLE SWITCHER™ is a trademark of National Semiconductor Corporation.

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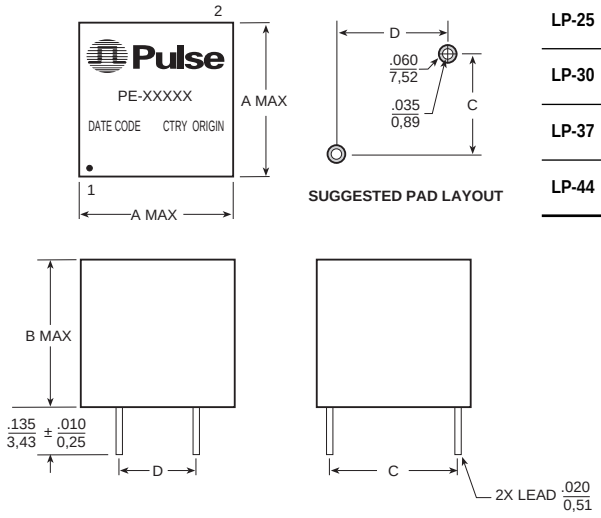
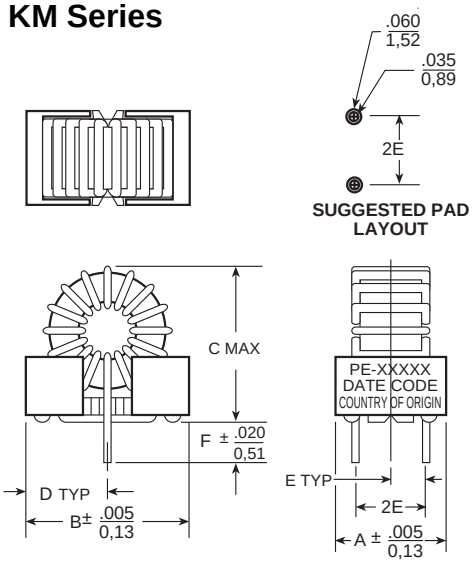
Mechanicals

LP Series



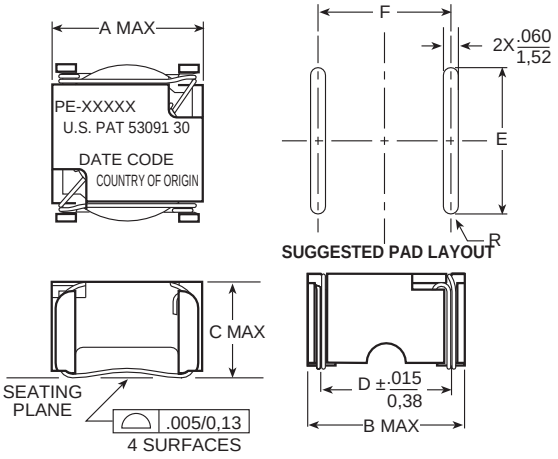
PKG	A	B	C	D
LP-25	.360 9,14	.310 7,87	.250 6,35	.250 6,35
LP-30	.400 10,16	.300 7,62	.300 7,62	.300 7,62
LP-37	.495 12,57	.375 9,52	.375 9,52	.375 9,52
LP-44	.635 16,13	.365 9,27	.500 12,7	.300 7,62

KM Series



PKG	A	B	C	D	E	F
KM-10	.340 8,64	.580 14,73	.650 16,51	.290 7,37	.110 2,79	.130 3,30
KM-20	.450 11,43	.650 16,51	.700 17,73	.325 8,26	.150 3,81	.130 3,30
KM-30	.450 11,43	830 21,08	.950 24,13	.415 10,54	.150 3,81	.130 3,30
KM-40	.600 15,24	.950 24,13	1.00 25,4	.475 12,07	.225 5,72	.130 3,30

LCI Series

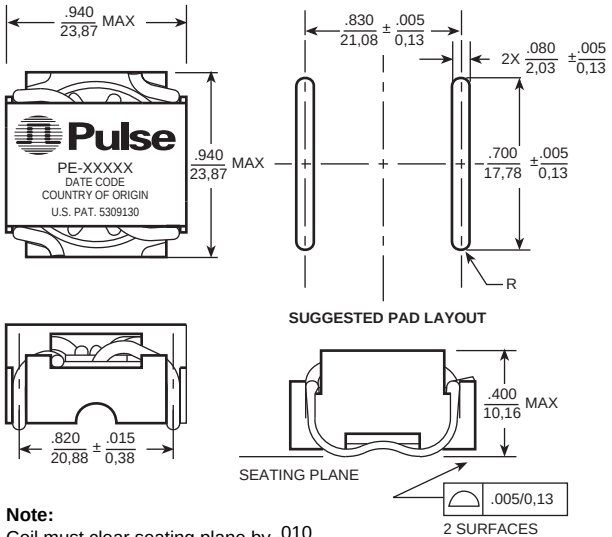


Notes:

1. Dimension "D" is measured across terminal blocks only.
2. Coil must clear seating plane by .010 / 0,25 MIN.

PKG	A	B	C	D	E	F
LCI-20	.340 8,64	.340 8,64	.270 6,86	.260 6,60	.300 7,62	.270 6,86
LCI-30	.435 11,05	.440 11,18	.360 9,14	.350 8,89	.400 10,16	.360 9,14
LCI-37	.565 14,35	.570 14,48	.360 9,14	.450 11,43	.520 13,21	.460 11,68
LCI-44	.600 15,24	.620 15,75	.390 9,91	.500 12,7	.550 13,97	.510 12,95
LCI-50	.670 17,02	.700 17,78	.390 9,91	.580 14,73	.620 15,75	.590 14,99

HCI-68



Note:
Coil must clear seating plane by .010 / 0,25 MIN

Dimensions: Inches / mm

Unless otherwise specified, all tolerances are ± .010 / 0,25

INDUCTORS DESIGNED FOR NATIONAL'S 50 KHz SIMPLE SWITCHER™

Pulse
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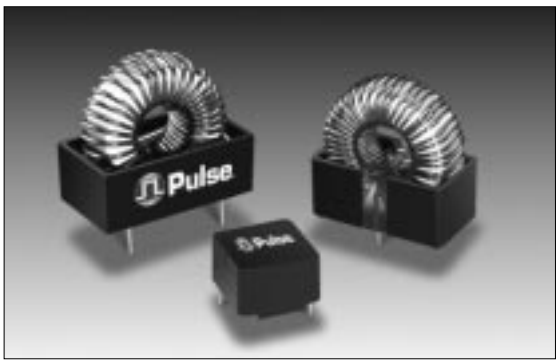

- Designed for use with National's device numbers LM2574/LM2575/LM2576
- Base material meets flammability requirements of UL 94V-0
- Performance verified by National Semiconductor

Electrical Specifications @ 25°C— Operating Temperature -30° to +130° C

Part Identification		Reference Operating Values[1]			Design Control Values			
Part Number	Inductor Code	Inductance Typical (µH)	I_{DC} (Amps)	ET_{OP} (V-µSec)	Inductance No DC[2] (µH ± 20%)	DCR (Ω MAX)	Package Style	Lead Diameter
PE-53112	L47	47	3.0	90	38	0.05	KM-2.0	.025
PE-92114K	L68	68	3.0	90	55	0.02	KM-4.0	.040
PE-92108K	L100	100	3.0	90	91	0.04	KM-4.0	.032
PE-53113	L150	150	2.0	90	130	0.10	KM-4.0	.025
PE-52626	L220	220	1.4	90	230	0.38	Low Profile	.025 SQ.
PE-53145	L220	220	1.4	90	176	0.14	KM-3.0	.020
PE-52627	L330	330	0.9	90	302	0.74	Low Profile	.025 SQ.
PE-53146	L330	330	0.9	90	267	0.18	KM-3.0	.020
PE-53114	L470	470	0.64	90	426	0.16	KM-4.0	.025
PE-52629	L680	680	.85	90	657	1.25	Low Profile	.025 SQ.
PE-53115	H150	150	3.0	200	136	0.10	KM-4.0	.025
PE-53116	H220	220	3.0	200	167	0.07	KM-5.0	.032
PE-53117	H330	330	3.0	200	292	0.15	KM-5.0	.025
PE-53118	H470	470	2.0	200	369	0.17	KM-5.0	.025
PE-53119	H680	680	1.3	200	562	0.20	KM-5.0	.025
PE-53120	H1000	1000	0.95	200	762	0.24	KM-5.0	.025
PE-53121	H1500	1500	0.62	200	1150	1.00	Case	.032
PE-53122	H220	2200	0.42	200	1730	1.80	Case	.032

NOTES:

1. Typical inductance occurs at the I_{DC} and ET_{OP} values shown.
2. The control value of inductance is measured at B_{OP} equal to or less than 10 gauss (10 mV @ 20 KHz) without DC current.
3. Inductance decreases with higher values of DC current and increases with lower values of DC current.
4. Inductance increases with increase in B_{OP} or ET_{OP}.
5. SIMPLE SWITCHER™ is a trademark of National Semiconductor Corporation.

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INDUCTORS DESIGNED FOR NATIONAL'S 50 KHz SIMPLE SWITCHER™

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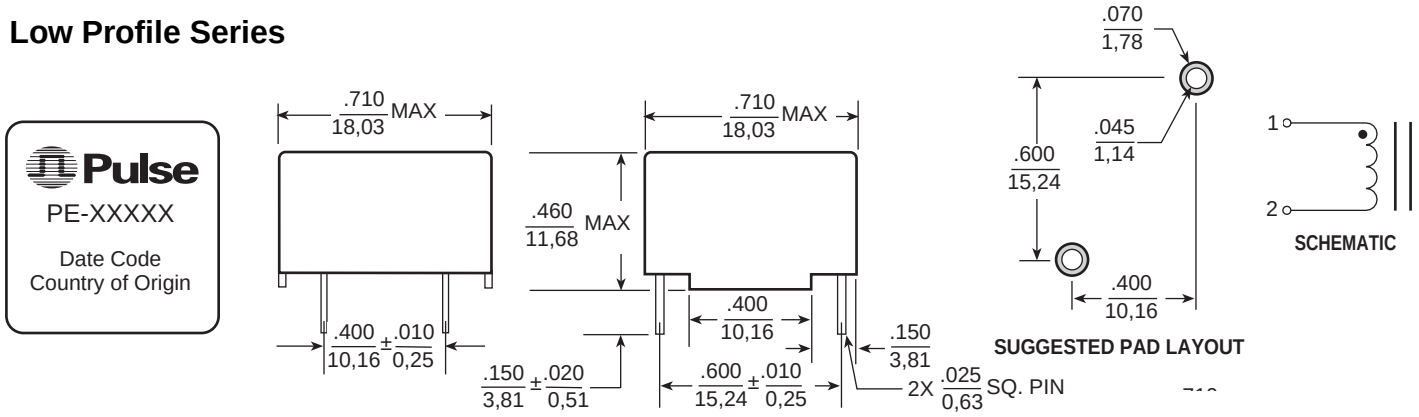
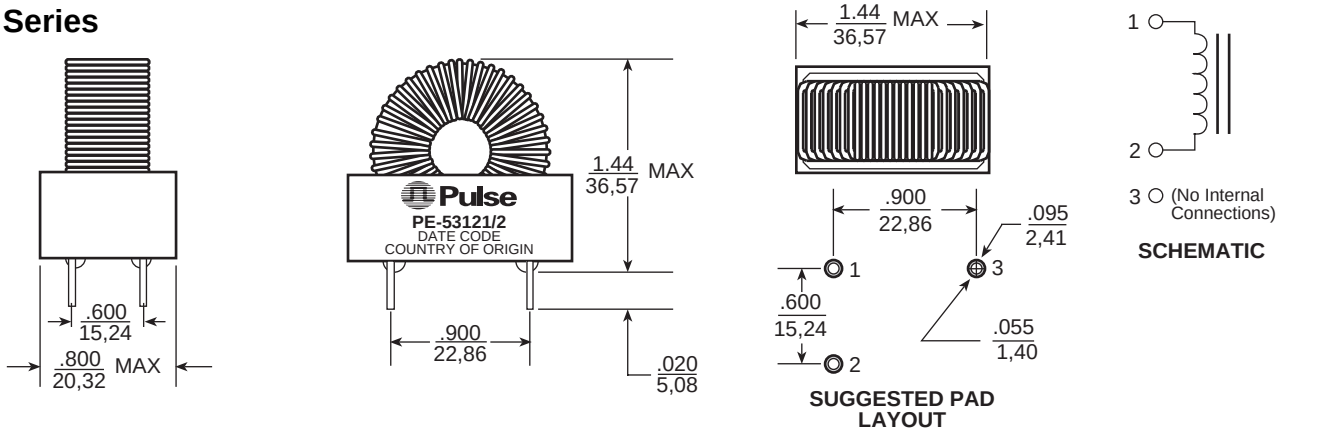
Mechanicals

Low Profile Series



Case Series

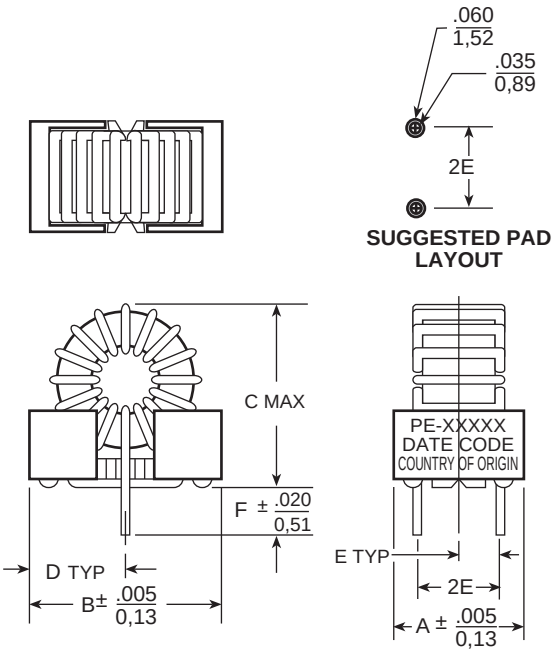


KlipMount Series

PKG	A	B	C	D	E	F
KM-2.0	.450 11,43	.650 16,51	.700 17,73	.325 8,26	.150 3,81	.130 3,30
KM-3.0	.450 11,43	.830 21,08	.950 24,13	.415 10,54	.150 3,81	.130 3,30
KM-4.0	.600 15,24	.950 24,13	1.00 25,4	.475 12,07	.225 5,72	.130 3,30
KM-5.0	.700 17,73	1.30 33,02	1.40 35,56	.625 15,88	.250 6,35	.130 3,30

Dimensions: Inches / mm

Unless otherwise specified, all tolerances are ± .010 / 0,25



INDUCTOR FOR HARRIS SEMICONDUCTOR

Portable Power Converter HIP 5020 Eval 1

Pulse
A TECHNITROL COMPANY

NEW!

- Surface mount, self-leaded inductor
- Solution based on efficiency, using Allied Microlite core
- Designed for Notebooks, portables and PCAs
- Wide variety of other inductor sizes and values available

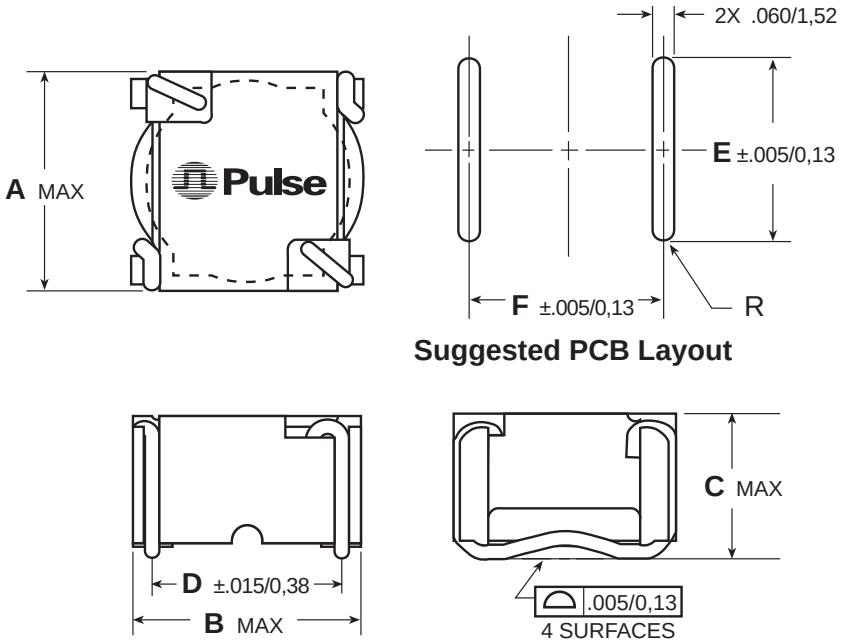
Electrical Specifications @ 25°C — Operating Temperature -30°C to +130°C

Pulse Part Number	Reference Values				Control Values		Calculation Data	
	I_{DC} (amp)	L @ DC L_{DC} (µH)	ET (V-µsec)	Storage Capacity (µJoules)	L w/o DC L_0±20% (µH)	DCR MAX (mΩ)	100 Gauss ET_{100} (V-µsec)	1 Amp DC H_1 (Orsted)
P0119	4.96	7.4	14.34	90.43	12.7	18.2	1.20	7.42

NOTES:

1. The reference inductance is a typical value at the AC and DC excitation listed.
2. Temperature rise is 55° C in typical buck or boost circuits at 200 KHz and with the reference ET applied to the inductor.
3. Total loss in the inductor is 423 mWatts for 55°C temperature rise above ambient.
4. To estimate temperature rise in a given application, determine the total losses (copper losses + core losses), divide by 423 and multiply by 55.
5. To determine copper losses, calculate:
   CopperLoss (mW) = I_{DC}^2 x R_N (with R_N in mΩ).
6. The maximum DCR listed is approximately 17% over the nominal DCR (R_N).
7. For core loss in mWatts, using frequency (f, Hz) and operating flux density (B, Gauss), calculate: $0.342 \times 10^{-12} \times B^{2.13} \times f^{1.52}$.
8. For flux density (B, Gauss), calculate ET (V-µsec) for the application, divide by ET_{100} factor from the table and multiply by 100.
9. For estimating L with DC current, calculate H by multiplying H_1 from the table by I_{DC} of the application. Using H determine the DC perm Factor (F_{UDC}). Multiply L w/o DC by F_{UDC} for L @ DC.

Mechanical



Suggested PCB Layout

Schematic

Weight . . . . . 2.4 grams
Tube 30/tube

A	B	C	D	E	F
.565 14,35	.570 14.48	.360 9,14	.450 11.43	.520 13.21	.460 11.68

Dimensions: Inches / mm
Unless otherwise specified, all tolerances are ± .010 / 0,25

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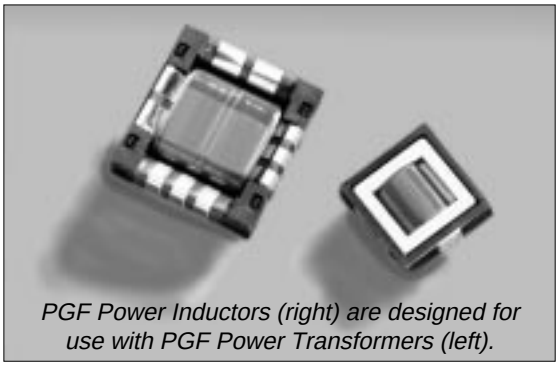
PGF POWER INDUCTORS

High Current, Low Profile, High Frequency

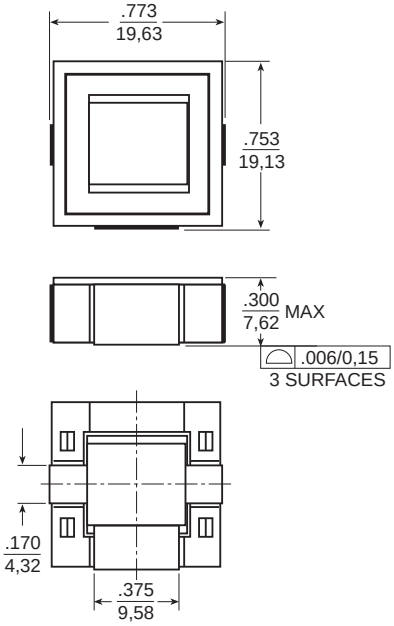


PGF Power Inductors (right) are designed for use with PGF Power Transformers (left).

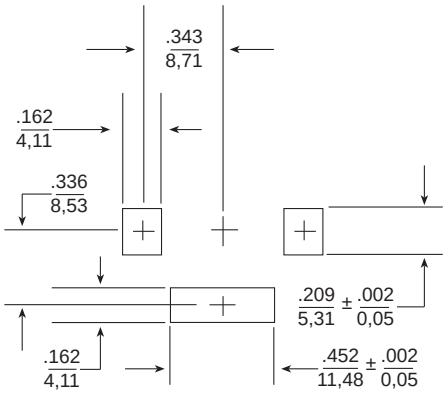
- 15 AMP current capability
- Surface mount
- Heat sinkable

Electrical Specifications* @ 25°C — Operating Temperature -20°C to +85°C						
Part Number	**Inductance ± 30% at 0 ADC** (µH)	**Inductance ±30% at IDC** (µH)	**IDC** (MAX ADC at ET MAX)	**ET MAX*** (V-µSec)	**F0** (KHz)	**DCR MAX.** (milli Ohms)
PE-53974	3.2	1.75	15	6	200-750	4.3
PE-53975	6.7	3.5	10	9	150-750	8.4

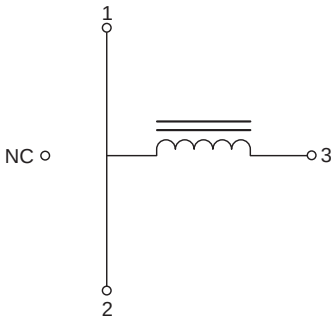
Mechanical



Footprint



Schematic



Dimensions: Inches / mm

Unless otherwise specified, all tolerances are ± .010 / 0,25

Application

These inductors are designed for high current at high ripple frequency. Overall height is 300 mils ±10%. The PE-53974 and PE-53975 power inductors are designed to be used with the PE-68471 and PE-68472 surface mount power transformers.

***NOTE:** Specifications are tabulated for 250 KHz operation at 45°C temperature rise with convection cooling only. Heatsinked applications provide higher current and Volt-Microsecond capability.

LOW PROFILE SELF-LEADED CURRENT SENSE INDUCTORS

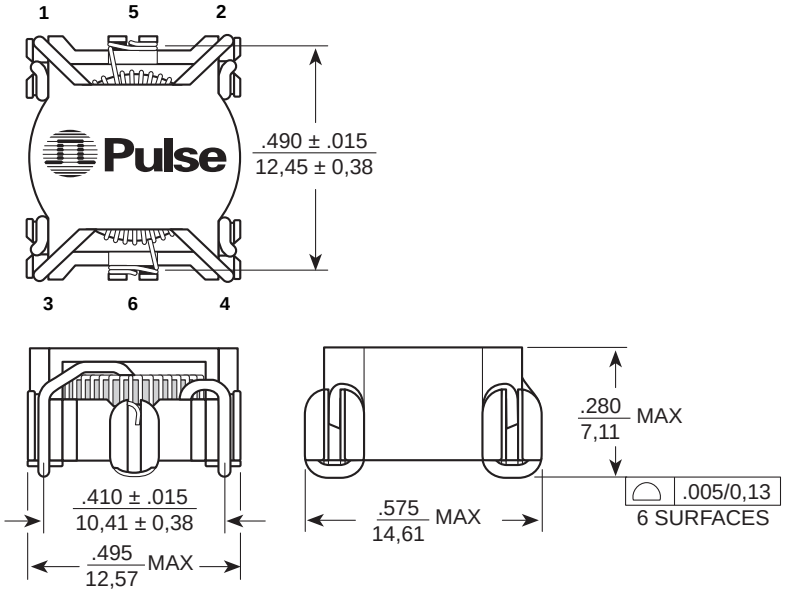
- Self-leaded, surface mount
- Suited for IR and vapor phase reflow soldering
- Designed for switching power supply applications

Electrical Specifications @ 25°C — Operating Temperature -30°C to 130°C

Part Number	I (Amps)	R_T (Ω)	Droop (%)	L_S (mH MIN)	R_S (Ω MAX)	Turns (N_S)	Hipot (V_{RMS})
PE-68210	15.3	25	1.3	3.8	.38	50	500
PE-68280	16.3	50	0.7	14.8	.93	100	500
PE-68383	16.4	100	0.3	59.2*	3.9	200	500

NOTES:
1. Inductance is measured at 100 KHz, 20 mVrms. *10KHz, 60 mVrms.
2. Hipot is 500 Vrms, measured at 60 Hz, 2 seconds.
3. I, R_T, and Droop are reference values only.
4. Reference values are for the one turn winding connected in parallel for unipolar operation at 200 KHz.

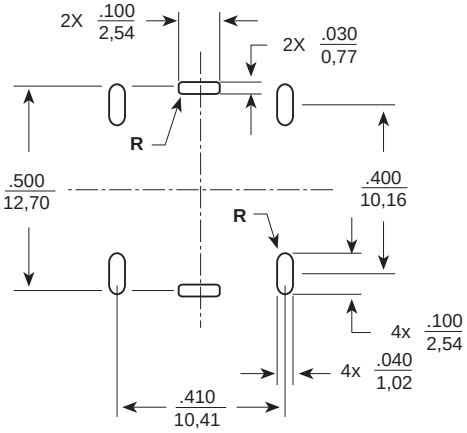
Mechanical



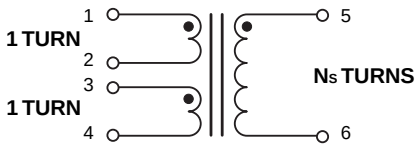
Unless otherwise specified, all tolerances are ± 0.005 / 0,127

Dimensions: Inches / mm

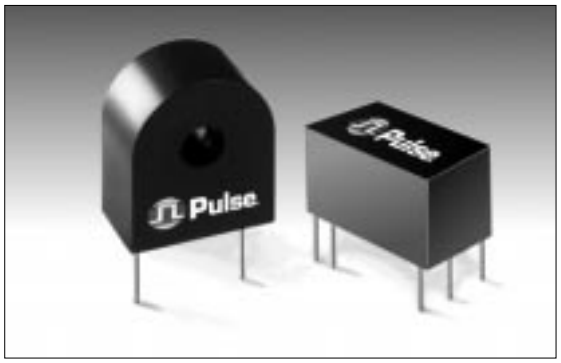
Footprint



Schematic



THOUGH HOLE CURRENT SENSE TRANSFORMERS AND INDUCTORS



- VDE Approved
- Designed for switching power supply applications
- Transformer meets IEC950 insulation requirements
- Frequency range from 20 KHz to 200 KHz

Electrical Specifications @ 25°C — Operating Temperature -30°C to 130°C

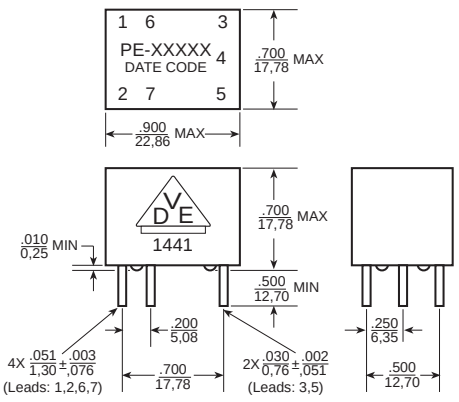
Part Number Transformer with 2-1 T Primaries	Schem. Figure	Part Number Transformer with 1T Primary	Schem. Figure	Part Number Inductor without Primary	Schem. Figure	Turns N_S	Secondary Inductance MH (MIN)	Secondary Inductance Test Voltage (15.75 KHz)	RS (Ω MAX)	RT (Ω NOM)	Primary Unipolar Amp µ Sec. Rating (MAX)	Primary Bipolar Amp µ Sec. Rating (MAX)
—	1C	**PE-63586**	1A	**PE-51686**	2A	50	5.0	0.5	0.7	50	150	300
PE-64487	1C	**PE-63587**	1A	**PE-51687**	2A	100	20.0	1.0	1.40	100	300	600
PE-64488	1C	**PE-63588**	1A	**PE-51688**	2A	200	80.0	2.0	4.50	200	600	1200
PE-64517	1D	**PE-63617**	1B	**PE-51717**	2B	50CT	5.0	0.5	0.7	50	150	300
PE-64518	1D	**PE-63618**	1B	**PE-51718**	2B	100CT	20.0	1.0	1.40	100	300	600
PE-64519	1D	**PE-63619**	1B	**PE-51719**	2B	200CT	80.0	2.0	4.50	200	600	1200
—	—	**PE-63691**	1B	—	—	300CT	180.0	3.0	11.0	300	900	1800

NOTES:

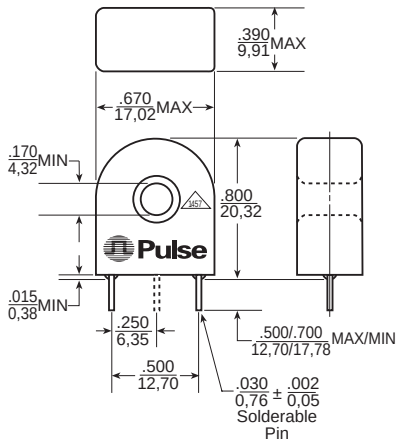
1. Maximum ratings specified with rated secondary terminating resistance and 1 turn primary.
2. Amp-microsecond (AµSec.) rating of primary equals volt microsecond (VµSec.) rating of secondary when secondary is terminated in rated resistance. (Amp—microseconds is equal to the product of a square pulse of current in amps, times the current pulse width in microseconds.
3. Maximum operating temperature 105°C (ambient plus rise).
4. When terminated with rated terminating resistance, the inductor scale factor is Vout = 1 volt per amp. for center tapped units terminating resistance for each half of winding is listed value divided by two.
5. 1 turn primary peak sense current is 20 amps for all parts listed above.

Mechanicals

Transformer



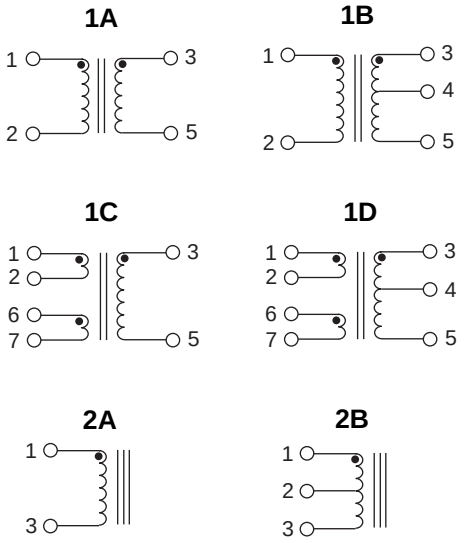
Inductor



Unless otherwise specified, all tolerances are ± .005 / 0,13

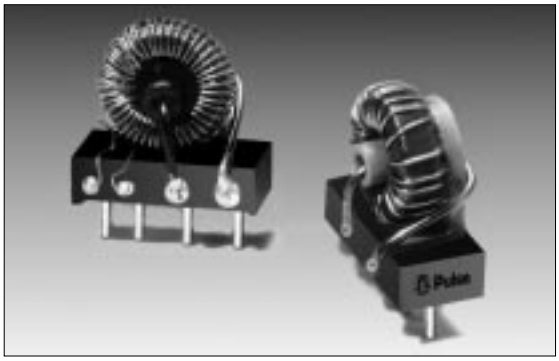
Dimensions: Inches / mm

Schematics



500 KHz CURRENT SENSE TRANSFORMERS & INDUCTORS

Through Hole Package



- Frequency range from 200 to 500 KHz
- 1250 V_{RMS} isolation
- 20 Amp peak sense current

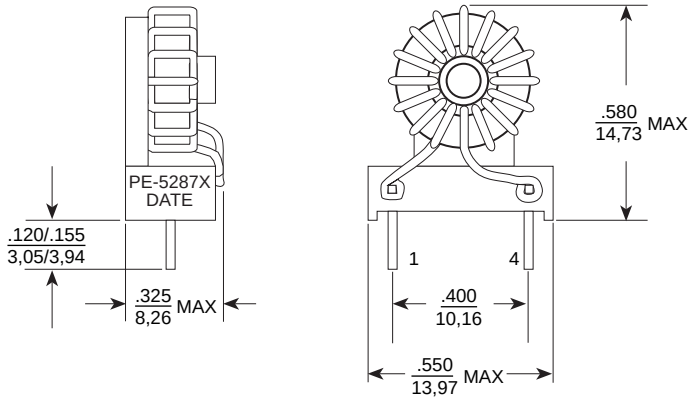
Electrical Specifications @ 25°C — Operating Temperature -30°C to 130°C

Part Number Inductor	Part Number Transformer	RT[1] (Ω)	Secondary Turns[2] N_S	Secondary Inductance[3] (µH MIN)	DCR Secondary (Ω MAX)	DCR Primary (Ω)	Vs (mV)
PE-52876	**PE-64976**	1.50	10	150	.055	.006	30
PE-52877	**PE-64977**	3.00	20	600	.097	.006	60
PE-52878	**PE-64978**	7.50	50	4000	.240	.006	160

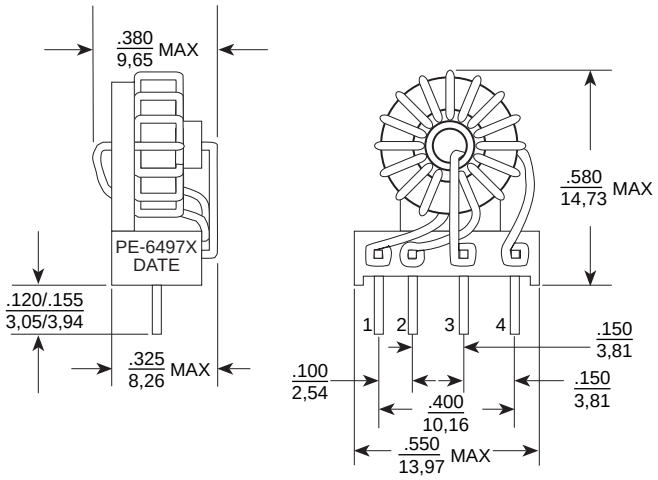
NOTES: 1. Terminating resistance for .15 Volt/Amp
2. ± 1 turn
3. @ 100 KHz, @ Vs

Mechanicals

Inductor



Transformer

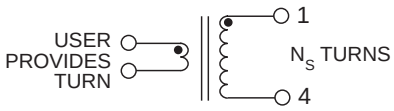


Dimensions: Inches / mm

Unless otherwise specified, all tolerances are ± .010 / 0,25

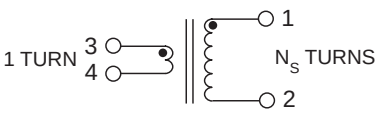
Schematics

Inductor



PE-52876, PE-52877, PE-52878

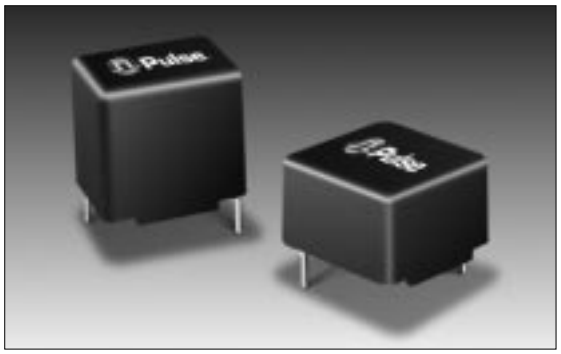
Transformer



PE-64976, PE-64977, PE-64978

STANDARD LOW POWER INDUCTORS

Switch Mode Power Converters and Ripple Filters



- Designed for general purpose use
- High inductance stability with varying volt-seconds and load currents
- Compact, standard packages
- Low profile or vertical packages

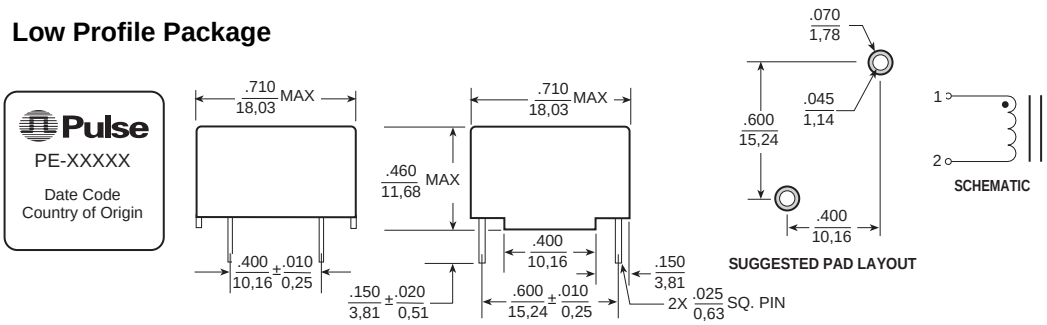
Electrical Specifications @ 25°C — Operating Temperature -30°C to 130°C

Reference Operating Values						Design Control Values		
Low Profile Part Number	Vertical Part Number	Inductance Typical (µH)	I_{DC} (AMPS)[1]	Maximum ET_{OP}[2] (V-µSec)	Energy Storage (µJ)[1]	Inductance No DC (µH ± 20%)	20 KHz Test mV No DC	DCR (Ω MAX)
PE-52625	**PE-52645**	150	1.7	80	215	145	110	.42
PE-52626	**PE-52646**	220	1.5	90	240	226	140	.42
PE-52627	**PE-52647**	330	1.0	100	165	316	170	.78
PE-52628	**PE-52648**	470	.90	120	190	480	210	1.26
PE-52629	**PE-52649**	680	.85	175	245	690	250	1.50
PE-52630	**PE-52650**	820	.75	175	230	780	270	2.40
PE-52631	**PE-52651**	1000	.50	175	125	975	300	2.60

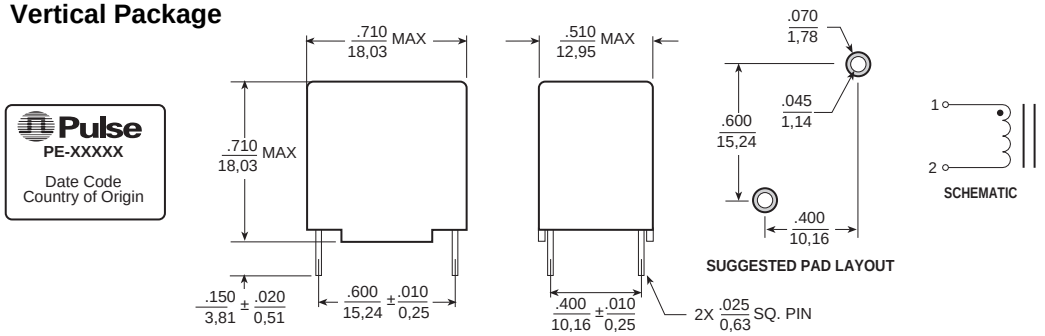
NOTES: 1. I_{DC} rated for 40°C Temperature rise @ low ET_{OP}. 2. Derate current 20% at this ET_{OP}.

Mechanicals

Low Profile Package



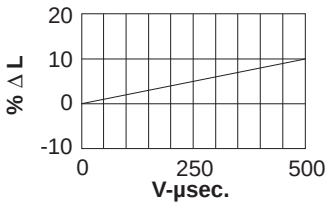
Vertical Package



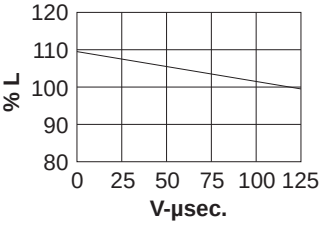
Unless otherwise specified, all tolerances are ± .010 0,25

Dimensions: inches / mm

Inductance Characteristics



Inductance Variance vs. E.T.



Inductance Variance vs. Load Current

LOW COST INDUCTORS
Electrical Information

- Available in vertical, low profile and *Klipmount™*
- SMPS averaging filter
- Characterized for general purpose use and ripple filters
- Single-layer designs
- Can be used as differential mode inductors in EMI filters[3]

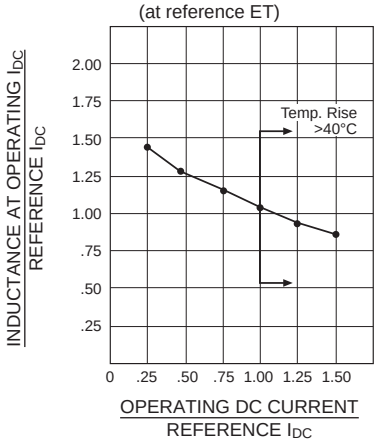
Electrical Specifications @ 25°C — Operating Temperature -30°C to 130°C

Reference Operating Values						Design Control Values					
Vertical Part Number	Low Profile Part Number	Inductance Typical (µH)[1]	I_{DC} (AMPS)	ET_{OP} (V-µSec)	Energy Storage (µJ)[4]	Inductance No DC (µHy) ±20%	20 KHz Test mV No DC[2]	DCR (Ω MAX)[5]	Coil Size Code	Klip Mount Package*	Lead Diameter (In) ±.003
PE-51591	—	20	2.0	52	40	32.8	33	.060	H	—	.020
PE-92100	—	25	2.6	30	85	20.7	22	.043	A	KM1	.020
PE-92101	**PE-92401**	50	2.6	50	169	45.7	45	.071	B	KM2	.020
PE-92102	**PE-92402**	100	2.6	90	338	94.1	90	.100	C	KM3	.020
PE-92103	—	35	2.6	55	118	28.4	36	.037	B	KM2	.025
PE-92104	**PE-92404**	70	3.0	85	315	61.0	73	.052	C	KM3	.025
PE-92105	**PE-92405**	145	3.0	140	653	141.8	140	.087	D	KM4	.025
PE-92106	—	285	3.0	300	1283	264.1	340	.140	E	KM5	.025
PE-92107	—	450	3.0	425	2025	436.3	500	.200	F	—	.025
PE-92108	**PE-92408**	100	3.6	130	648	90.7	110	.045	D	KM4	.032
PE-92109	—	165	4.0	240	1320	152.0	260	.070	E	KM5	.032
PE-92110	—	270	4.0	350	2160	263.9	400	.100	F	—	.032
PE-92111	—	40	4.0	70	320	37.9	57	.027	C	KM3	.032
PE-51590	—	22	5.0	44	275	20.3	37	.020	G	—	.032
PE-92112	**PE-92412**	100	5.0	200	1250	90.7	180	.034	E	KM5	.042
PE-92113	—	170	5.0	300	2125	159.7	310	.050	F	—	.042
PE-92114	**PE-92414**	55	5.0	100	688	54.9	88	.023	D	KM4	.042
PE-92115	—	95	7.0	225	2328	96.0	200	.025	F	—	.051
PE-92116	**PE-92416**	55	7.0	150	1348	49.1	100	.017	E	KM5	.051
PE-92117	—	55	10.0	175	2750	55.9	120	.013	F	—	.064

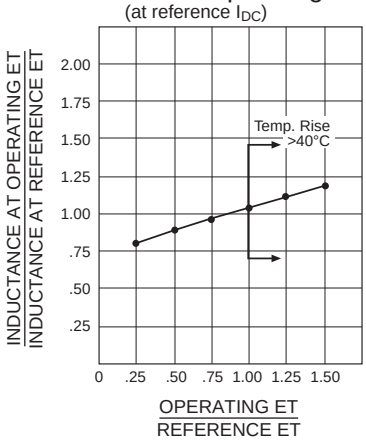
*Parts available with ***KlipMount*** option can be ordered by adding a "K" suffix to the part number (i.e. PE-92100**K**).

Relationships Between Reference and Operating Conditions

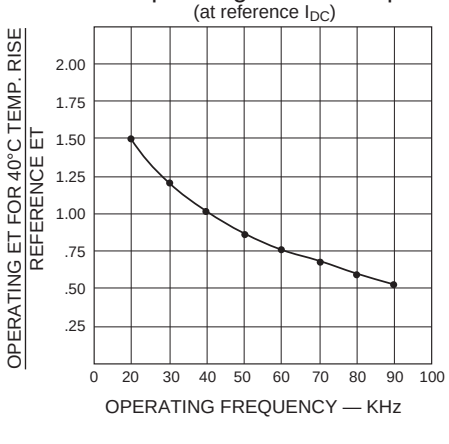
Inductance vs. DC Current
(at reference ET)



Inductance vs. Operating ET
(at reference I_{DC})



Max. Operating ET vs. Frequency
(at reference I_{DC})



LOW COST INDUCTORS
Mechanical Information

Mechanicals

- Base material meets flammability requirements of UL 94V-0
- Mechanically rigid mount
- PC board — automatic insertability
- Lowest cost

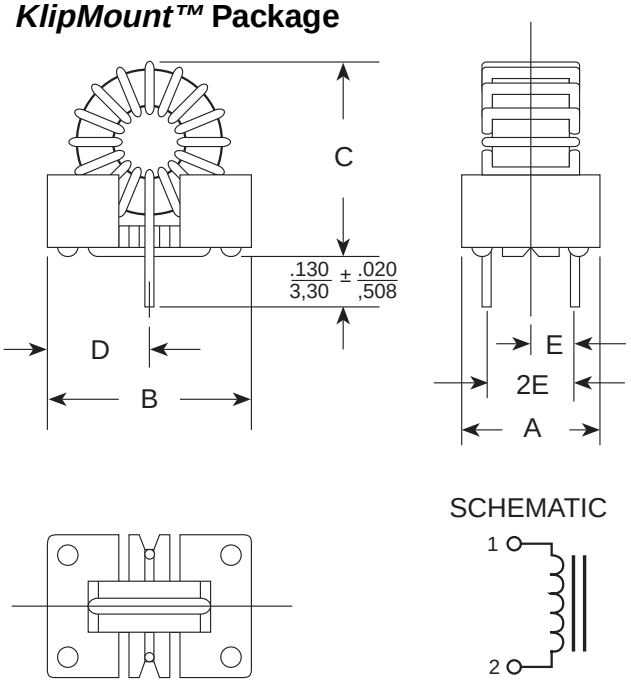
Standard Package	A	B	C	D	E
	Nom. ± .005/0,13		Nom.	Typical	
KM-1	.340 / 8,64	.580 / 14,73	.650 / 16,57	.29 / 7,37	.110 / 2,79
KM-2	.450 / 11,43	.650 / 16,51	.700 / 17,78	.325 / 8,26	.150 / 3,91
KM-3	.450 / 11,73	.830 / 21,03	.950 / 24,13	.415 / 10,54	.150 / 3,91
KM-4	.600 / 15,24	.950 / 24,13	1.10 / 27,94	.475 / 12,07	.225 / 5,72
KM-5	.700 / 17,78	1.3 / 33,02	1.40 / 35,56	.625 / 15,88	.250 / 6,35

Note: Units with large wire sizes may exceed B dimension.
KLIPMOUNT™ is a trademark of Pulse Engineering, Inc.

Dimensions: Inches / mm

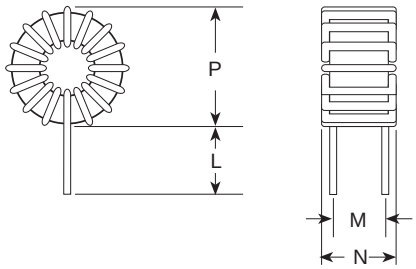
Unless otherwise specified, all tolerances are ± .010 / 0,25

KlipMount™ Package

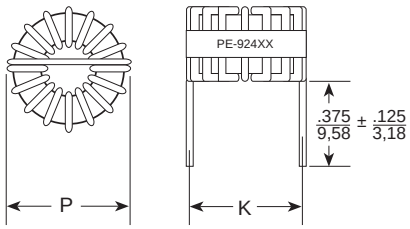


Coil Size	P (MAX)	N (MAX)	L (+.125/-.025)	M	K
A	0.55 / 13,97	0.25 / 6,35	.375 / 9,53	.180 / 4,57	—
B	0.70 / 17,78	0.38 / 9,65	.375 / 9,53	.280 / 7,11	.530 / 13,46 ± .050 / 1,27
C	0.85 / 21,59	0.41 / 10,41	.375 / 9,53	.280 / 7,11	.720 / 18,29 ± .050 / 1,27
D	1.05 / 26,27	0.55 / 13,97	.375 / 9,53	.400 / 10,16	.840 / 21,24 ± .020 / ,51
E	1.40 / 35,56	0.700 / 17,78	.375 / 9,53	.500 / 12,7	1.10 / 25,65 ± .100 / 2,54
F	1.65 / 41,91	0.700 / 17,78	.375 / 9,53	.500 / 12,7	—
G	0.85 / 21,59	0.33 / 8,38	.875 / 22,23	—	.730 / 18,29 ± .05 / 1,27
H	0.64 / 16,26	0.28 / 7,11	.875 / 22,23	—	.530 / 13,46 ± .05 / 1,27

Vertical Package



Low Profile Package

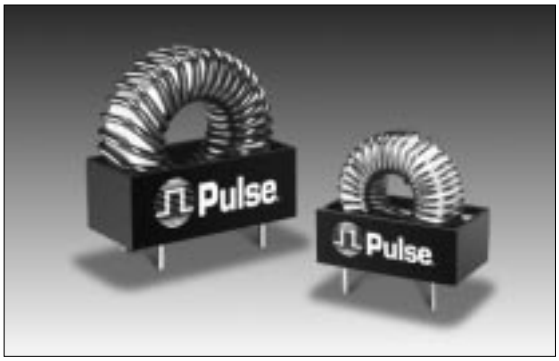


NOTES:

1. Typical Inductance occurs at I_{DC} and ET_{OP} values shown.
2. Design control test voltage critical. Inductance increases with voltage.
3. For line filter applications RMS line current is limited to specified reference DC Current.
4. $\frac{LI^2}{2}$ rating is the ability of the inductor to store energy.
5. DCR for vertical part measured close to coil. Add 10% more for Low Profile part.

TOROIDAL INDUCTORS
HIGH CURRENT

Pulse
A TECHNITROL COMPANY



- Cost-effective designs
- Semi-encapsulated construction
- Maximum operation temperature of 130°C (Ambient + Rise)
- A 2:1 inductance swing from zero to maximum current

Electrical Specifications @ 25°C

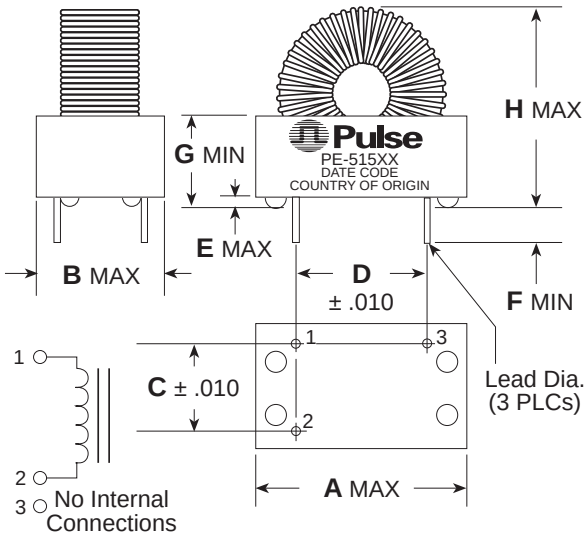
Reference Operating Values						Design Control Values				
Part Number	Inductance Typical (µH)2	I_{DC} (AMPS)	ET_{OP}1 (V-µSec)		Energy Storage (µJ MIN)3	Inductance No DC (µH) (±20%)	50 KHz Test mV No DC5	DCR (Ω MAX)	Size Code	Lead Diameter (in ±.003)
			20 KHz	40 KHz						
PE-51506	17.0	17.0	190	130	2460	40.0	140	0.0065	3	0.081
PE-51507	32.0	16.0	290	200	4100	70.7	270	0.0092	4	0.081
PE-51508	60.0	16.0	390	270	7700	120.0	470	0.012	5	0.081
PE-51509	14.0	10.0	135	95	700	28.5	73	0.009	1	0.057
PE-51510	23.0	11.0	170	120	1400	43.5	130	0.012	2	0.057
PE-51511	43.0	10.0	280	195	2150	85.5	210	0.018	3	0.057
PE-51512	90.0	10.0	430	300	4500	158.0	420	0.028	4	0.057
PE-51513	144.0	10.0	570	400	7200	262.0	700	0.032	5	0.057
PE-51514	32.0	6.6	200	140	700	60.5	110	0.025	1	0.040
PE-51515	52.0	7.0	230	160	1275	92.0	190	0.032	2	0.040
PE-51516	98.0	6.0	400	280	1765	188.0	310	0.048	3	0.040
PE-51517	175.0	6.0	620	425	3150	315.0	560	0.068	4	0.040
PE-51518	335.0	6.0	840	580	6030	571.0	1000	0.095	5	0.040
PE-51520	400	3.6	600	420	2700	688.0	640	0.130	3	0.036

Notes:

1. To prevent excessive temperature rise, limit ET_{OP} to the rated ET_{OP} specified. This is not a saturation limit. Temperature rise of inductors is 40°C MAX at MAX current and rated ET_{OP}.
2. A 2:1 nominal inductance swing from no I_{DC} to operating I_{DC} gives improved protection against current discontinuities at light loading. Inductance increases with greater ET_{OP}. Reference values occur at I_{DC} and low flux density.
3. $\frac{LI^2}{2}$ rating is the ability of the inductor to store energy.
4. Design control test voltage is critical. Inductance increases with voltage.

Size Code	1	2	3	4	5	6
A	1.20/30,48	1.44/36,57	1.60/40,64	1.95/49,53	2.30/58,42	1.30/33,02
B	0.60/15,24	0.80/20,32	0.80/20,32	0.91/23,11	1.11/28,21	0.90/22,86
C	0.40/10,16	0.60/15,24	0.60/15,24	0.70/17,78	0.90/22,85	0.66/16,76
D	0.80/20,32	0.90/22,86	0.90/22,86	1.20/30,48	1.50/38,10	0.75/19,05
E	0.45/11,43	0.70/17,78	0.70/17,78	0.90/22,86	1.00/25,40	0.41/10,41
F	0.20/5,08	0.20/5,08	0.20/5,08	0.20/5,08	0.20/5,08	0.10/2,54
G	.015/0,381	0.03/0,76	0.03/0,76	0.03/0,76	0.03/0,76	.015/0,381
H	1.20/30,48	1.44/36,57	1.72/43,68	2.00/50,80	2.30/58,42	1.40/35,56

Mechanicals

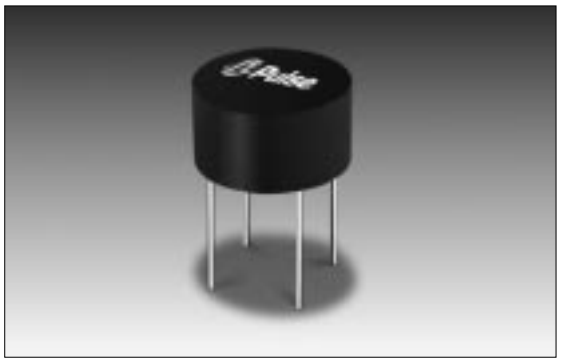


Dimensions: Inches / mm

Unless otherwise specified, all tolerances are ± .010 / 0,25

TOROIDAL INDUCTORS
HIGH INDUCTANCE

Pulse
A TECHNITROL COMPANY



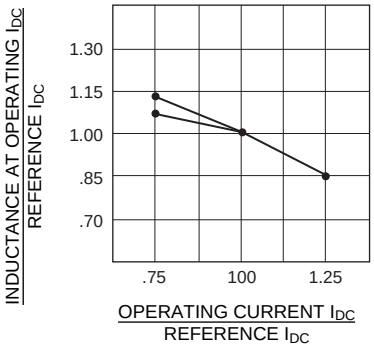
- High frequency, low loss operation (up to 100 KHz)
- Encapsulated construction
- Ambient temperature range of -55°C to +70°C
- Good inductance stability with temperature

Electrical Specifications @ 25°C

	Reference Operating Values				Design Control Values		
Part Number	Inductance Typical (mH)	I_{DC} (AMPS)	Maximum ET_{OP} (V-µSec)	Energy Storage (µJ MIN)1	Inductance No DC (mHy) (±20%)2	DCR (Ω MAX)	Size Code
PE-50500	0.5	.60	110	90	.72	0.35	7
PE-50501	1.0	.35	160	60	1.51	0.75	7
PE-50502	2.0	.25	225	60	2.88	1.30	7
PE-50503	0.5	1.75	325	765	.72	0.35	8
PE-50506	0.5	2.75	650	1890	.75	0.25	9
PE-50508	2.0	1.50	1200	2250	2.70	0.75	9

NOTES: **1.** $\frac{LI^2}{2}$ rating is the ability of the inductor to store energy. 2. Inductance measured at 0.4 Volts and 20KHz.

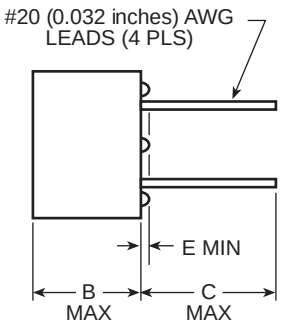
Inductance Variation with I_{DC} Change

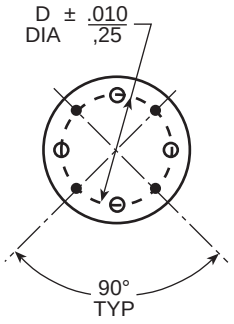


Dimensions: Inches / mm

Unless otherwise specified, all tolerances are ± .010 / 0,25

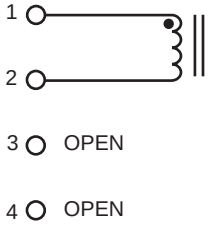
Mechanical

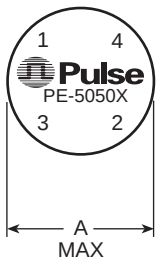




Size Code	A	B	C	D	E
7	.754 / 18,92	.400 / 10,16	.500 / 12,70	.625 / 15,87	0.03 / 0,76
8	1.140 / 28,95	.665 / 16,89	.500 / 12,70	1.00 / 25,40	0.03 / 0,76
9	1.416 / 35,96	.850 / 21,59	.500 / 12,70	1.250 / 13,75	0.03 / 0,76

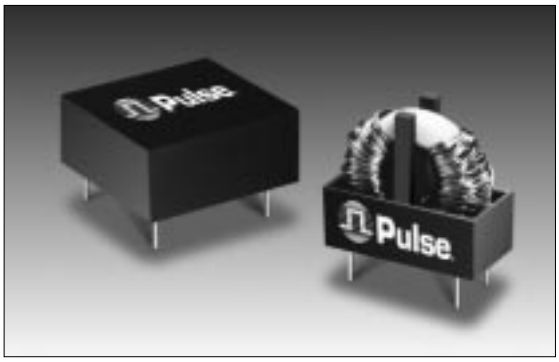
Schematic





COMMON MODE EMI SUPPRESSION INDUCTORS

Pulse
A TECHNITROL COMPANY



- Low profile or vertical mounting available
- Windings balanced within one percent
- For use in switching power supply input filter circuits
- Dielectric strength 1250 Vrms
- Designed with 3.0 mm minimum creep distance between windings

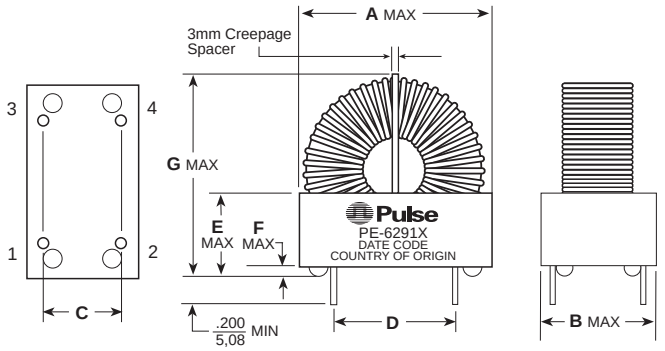
Electrical Specifications @ 25°C— Operating Temperature -30° to +130° C

Low Profile Part Number	Vertical Mount Part Number	Rated RMS Current[1] (Amps)	Load VA[2] at RMS Line 117V	Load VA[2] at RMS Line 220V	Inductance at 1KHz (mH MIN)	Test Level Volts RMS 1.0KHz	Leakage Inductance 130KHz (µH MIN)	DCR Max. each WDG (Ω)	Package Number	Lead Diameter Inches ± .003 Low Profile	Lead Diameter Inches ± .003 Vertical Mount
PE-62891	**PE-62911**	1.8	210	420	10.0	0.50	130	0.240	1	0.032	0.032
PE-62892	**PE-62912**	3.5	400	800	3.0	0.20	35	0.060	1	0.032	0.032
PE-62893	**PE-62913**	6.0	700	1400	1.0	0.08	12	0.020	1	0.036	0.036
PE-62894	**PE-62914**	2.6	300	600	16.0	1.00	180	0.160	2	0.032	0.040
PE-62895	**PE-62915**	3.2	375	750	8.0	0.50	90	0.120	2	0.032	0.040
PE-62896	**PE-62916**	5.2	600	1200	4.0	0.20	45	0.040	2	0.036	0.036
PE-62897	**PE-62917**	7.5	875	1750	2.0	0.08	25	0.020	2	0.047	0.047

NOTES: 1. Rated RMS current for 40°C rise at any input voltage. 2. **Caution** — do not exceed rated RMS current ratings.

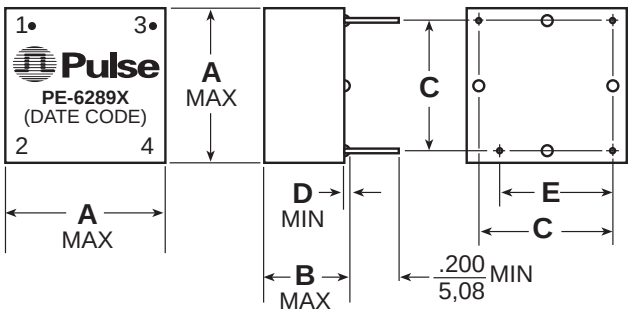
Mechanicals

Vertical Package



Package Number	A	B	C	D	E	F	G
1	1.15 / 29,21	.550 / 13,97	.400 / 10,15	.800 / 20,32	.45 / 11,43	.015 / 0,38	1.15 / 29,21
2	1.44 / 36,57	.800 / 20,32	.600 / 15,24	.900 / 22,86	.70 / 17,78	.030 / 0,76	1.50 / 38,10

Low Profile Package



Package Number	A	B	C	D	E
1	1.25 / 31,75	.600 / 15,24	1.00 / 25,40	.015 / 0,38	.900 / 22,86
2	1.50 / 38,10	.800 / 20,32	1.28 / 32,51	.010 / 0,25	1.083 / 27,50

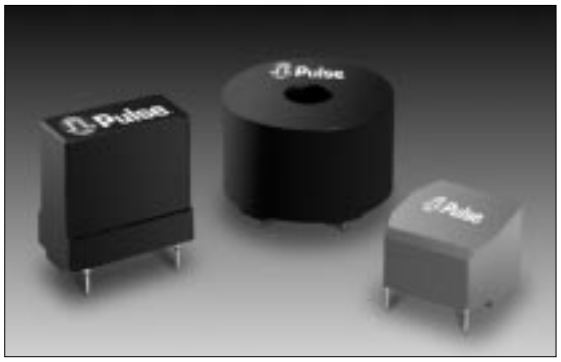
Unless otherwise specified, all tolerances are ± .010 / 0,25

Dimensions: Inches / mm

12220 WORLD TRADE DRIVE, SAN DIEGO, CALIFORNIA 92128 • TEL 619-674-8100 • FAX 619-674-8262 • http://www.pulseeng.com

500 KHz COMMON MODE EMI INDUCTORS

Pulse
A TECHNITROL COMPANY

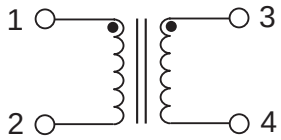


- Common mode EMI Inductors
- Designed for higher frequency power conversion
- For use in SMPS input filtering circuits

Elect. Specs. @ 25°C— Operating Temp. -30° to +130° C

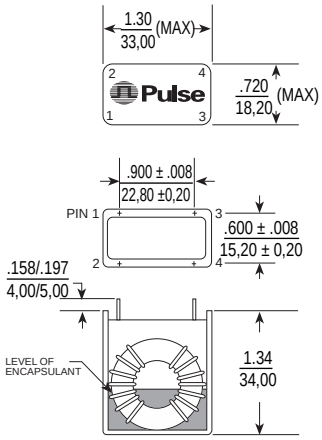
Part Number	Rated RMS Current (A.Normal)	Inductance mH (± 30%)	DCR Ohms (MAX)	Case Style	Leakage Inductance (MIN/MAX µH)	Self Resonant (KHz MIN)
PE-96161	0.5	33	1.40	3	160/320	125
PE-96165	1.0	18	0.50	1	120/320	250
PE-96166	1.0	5.6	0.30	3	30/60	850
PE-96168	2.0	15	0.29	1	100/220	250
PE-96173	3.15	5.6	0.10	1	40/80	450
PE-96175	3.15	3.3	0.07	3	15/35	1000
PE-96177	3.15	2.2	0.06	3	10/20	1400
PE-96178	3.15	1.2	0.04	3	6/15	2100
PE-96179	3.15	1.2	0.04	4	5/14	1600
PE-96181	5.0	3.9	0.06	1	25/60	650
PE-96186	6.3	2.7	0.04	1	20/45	650
PE-96187	8.0	3.3	0.033	2	20/45	600
PE-96188	10.0	1.8	0.02	2	10/25	850
PE-96189	12.5	1.5	0.015	2	10/20	900
PE-96190	15.0	1.0	0.01	2	7/15	1000

Schematic

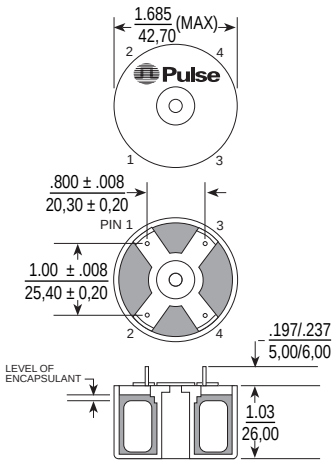


Mechanicals

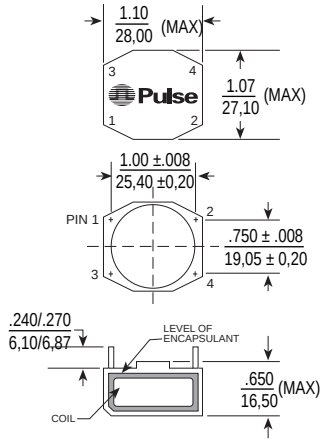
CASE 1[1]



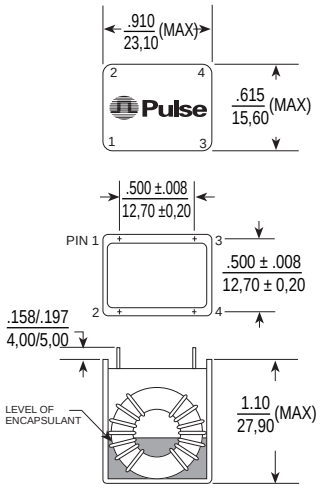
CASE 2[2]



CASE 3[1]



CASE 4[1]



Dimensions: Inches / mm

Unless otherwise specified, all tolerances are ± .010 / 0,25

NOTES: 1. Leads have .031/.039 / .700/.900 diameter.

2. Self-leaded: **96187** has .036 nom. diameter leads.
96188 and **96189** have .045 nom. diameter leads.
96190 has .051 nom. diameter leads.

Power Chokes – Vertical Mount

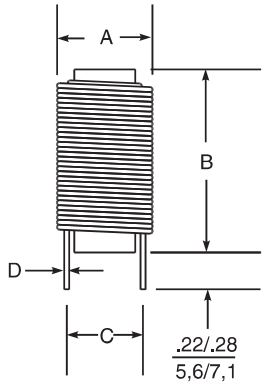
The Coilcraft PCV-0-and PCV-1 Series are low cost power inductors whose simple design provides rugged reliability and performance.

The open core construction of both series provides the highest saturation current available in a low cost power choke. The PCV-1 Series also incorporates a plastic mounting header for maximum lead protection and consistency.

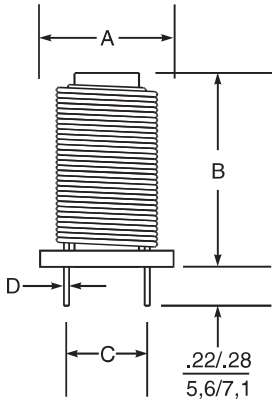
Coilcraft **Designer's Kit P205** contains samples of the values shown in bold as well as values from our PCV-2 Series. To order, contact Coilcraft.

- Low cost
- Wide range of standard values
- All 130°C class insulation

PCV-0 Series



PCV-1 Series



PCV-0 Series

Part Number	Inductance[1] (μH)	Current Rating[2] (Amps)	DCR Max (Ω)	A Max	B Max	C ± .015/0,38	D ± .004/0,10
PCV-0-102-25	1.0 ±15%	25	.002	.60/15,2	.68/17,3	.42/10,7	.068/1,73
PCV-0-102-10	1.0	10	.002	.50/12,7	.75/19,1	.42/10,7	.054/1,37
PCV-0-332-10	3.3	10	.005	.50/12,7	1.0/25,4	.42/10,7	.054/1,37
PCV-0-472-03	**4.7**	**3**	**.021**	**.51/13,0**	**.75/19,1**	**.42/10,7**	**.035/0,89**
PCV-0-472-05	**4.7**	**5**	**.012**	**.50/12,7**	**.75/19,1**	**.42/10,7**	**.042/1,07**
PCV-0-472-10	**4.7**	**10**	**.012**	**.50/12,7**	**1.0/25,4**	**.42/10,7**	**.054/1,37**
PCV-0-472-20	4.7	20	.004	.53/13,5	1.2/30,5	.42/10,7	.068/1,73
PCV-0-103-03	**10 ±10%**	**3**	**.023**	**.60/15,2**	**.75/19,1**	**.42/10,7**	**.035/0,89**
PCV-0-103-05	**10**	**5**	**.017**	**.50/12,7**	**.75/19,1**	**.42/10,7**	**.042/1,07**
PCV-0-103-10	**10**	**10**	**.015**	**.52/13,2**	**1.0/25,4**	**.42/10,7**	**.054/1,37**

[1] Tested at 15.75 kHz, .1 Vrms, with DC bias applied up to the rated current.
[2] Parts are designed for 40°C Max temperature rise at the rated current.
Parts in bold type are included in Coilcraft Designer's Kit No. P205.

1102 Silver Lake Road Cary, Illinois 60013 **Phone** 847/639-6400 **Fax** 847/639-1469
E-mail info@coilcraft.com **Data by Fax** 800/651-6974 **Web** http://www.coilcraft.com

PCV-0 Series – Continued

Part Number	Inductance[1] (μH)	Current Rating[2] (Amps)	DCR Max (Ω)	A Max	B Max	C ± .015/0,38	D ± .004/0,10
PCV-0-103-20	10 ±10%	20	.006	.75/19,1	1.8/45,7	.60/15,2	.075/1,91
PCV-0-153-03	15	3	.025	.50/12,7	1.0/25,4	.42/10,7	.035/0,89
PCV-0-153-10	15	10	.020	.50/12,7	1.0/25,4	.42/10,7	.054/1,37
PCV-0-223-03	**22**	**3**	**.035**	**.50/12,7**	**1.0/25,4**	**.42/10,7**	**.035/0,89**
PCV-0-223-05	**22**	**5**	**.023**	**.50/12,7**	**1.0/25,4**	**.42/10,7**	**.042/1,07**
PCV-0-223-10	**22**	**10**	**.015**	**.66/16,8**	**1.3/33,0**	**.42/10,7**	**.060/1,52**
PCV-0-273-05	27	5	.024	.50/12,7	1.0/25,4	.49/12,5	.042/1,07
PCV-0-333-12	33	12	.017	.70/17,8	1.3/33,0	.55/14,0	.060/1,52
PCV-0-473-03	**47**	**3**	**.050**	**.55/14,0**	**1.0/25,4**	**.42/10,7**	**.035/0,89**
PCV-0-473-05	**47**	**5**	**.035**	**.65/16,5**	**1.1/28,0**	**.70/17,8**	**.042/1,07**
PCV-0-473-10	**47**	**10**	**.022**	**.85/21,6**	**1.3/33,0**	**.70/17,8**	**.060/1,52**
PCV-0-823-03	82	3	.110	.50/12,7	.65/16,5	.375/9,5	.028/0,71
PCV-0-104-01	100	1	.190	.40/10,2	.90/22,9	.30/7,6	.020/0,51
PCV-0-104-03	**100**	**3**	**.072**	**.55/14,0**	**1.2/30,5**	**.70/17,8**	**.035/0,89**
PCV-0-104-05	**100**	**5**	**.055**	**.65/16,5**	**1.3/33,0**	**.70/17,8**	**.042/1,07**
PCV-0-154-03	150	3	.140	.60/15,2	1.2/30,5	.43/10,9	.028/0,71
PCV-0-154-05	150	5	.065	.65/16,5	1.3/33,0	.70/17,8	.042/1,07
PCV-0-184-05	180	5	.110	.60/15,2	1.2/30,5	.43/10,9	.035/0,89
PCV-0-224-03	220	3	.210	.55/14,0	1.2/30,5	.42/10,7	.025/0,64
PCV-0-274-04	270	4	.250	.95/24,0	.72/18,3	.71/18,0	.030/0,76
PCV-0-274-10	270	10	.160	1.1/28,0	1.0/25,4	.72/18,3	.038/0,97
PCV-0-394-03	390	3	.250	1.1/28,0	1.0/25,4	.72/18,3	.035/0,89
PCV-0-394-05	390	5	.190	1.1/28,0	1.0/25,4	.72/18,3	.038/0,97

PCV-1 Series

Part Number	Inductance[1] (μH)	Current Rating[2] (Amps)	DCR Max (Ω)	A Max	B Max	C ± .015/0,38	D ± .004/0,10
PCV-1-152-15	1.5 ±15%	15	.003	.65/16,5	.90/22,9	.42/10,7	.068/1,73
PCV-1-182-10	1.8	10	.006	.65/16,5	1.1/27,9	.42/10,7	.054/1,37
PCV-1-182-15	1.8	15	.003	.65/16,5	1.1/27,9	.42/10,7	.068/1,73
PCV-1-472-03	4.7	3	.021	.62/15,7	.85/21,6	.42/10,7	.035/0,89
PCV-1-472-05	4.7	5	.012	.62/15,7	.85/21,6	.42/10,7	.042/1,07
PCV-1-472-10	4.7	10	.012	.62/15,7	1.1/27,9	.42/10,7	.054/1,37
PCV-1-103-03	10 ±10%	3	.026	.63/16,0	.85/21,6	.42/10,7	.035/0,89
PCV-1-103-05	10	5	.020	.62/15,7	.85/21,6	.42/10,7	.042/1,07
PCV-1-103-10	10	10	.013	.63/16,0	1.1/27,9	.42/10,7	.054/1,37
PCV-1-153-10	15	10	.020	.70/17,8	1.4/35,6	.42/10,7	.060/1,52
PCV-1-223-03	22	3	.035	.62/15,7	1.1/27,9	.42/10,7	.035/0,89
PCV-1-223-05	22	5	.023	.62/15,7	1.1/27,9	.42/10,7	.042/1,07
PCV-1-223-10	22	10	.018	.70/17,8	1.4/35,6	.42/10,7	.060/1,52
PCV-1-473-03	47	3	.050	.65/16,5	1.1/27,9	.42/10,7	.035/0,89
PCV-1-473-05	47	5	.033	.90/22,9	1.2/30,5	.70/17,8	.042/1,07
PCV-1-473-10	47	10	.022	.90/22,9	1.4/35,6	.70/17,8	.060/1,52
PCV-1-104-03	100	3	.072	.90/22,9	1.3/33,1	.70/17,8	.035/0,89
PCV-1-104-05	100	5	.055	.90/22,9	1.4/35,6	.70/17,8	.042/1,07
PCV-1-184-03	180	3	.150	.63/16,0	1.2/30,5	.42/10,7	.028/0,71
PCV-1-304-10	300	10	.160	1.1/27,9	1.0/25,4	.70/17,8	.038/0,97
PCV-1-394-05	390	5	.190	1.1/27,9	1.0/25,4	.70/17,8	.038/0,97

[1] Tested at 15.75 kHz, .1 Vrms, with DC bias applied up to the rated current.
[2] Parts are designed for 40°C Max temperature rise at the rated current.
Parts in bold type are included in Coilcraft Designer's Kit No. P205.

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Axial Lead Power Chokes – PCH-27, 45

Coilcraft's horizontal mount power chokes provide a wide range of inductance in a low profile design.

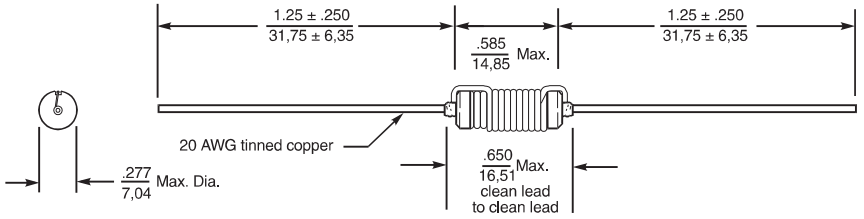
Two sizes are available; the compact PCH-27 Series, and the larger PCH-45 Series with higher current ratings.

They're ideal for use as output chokes in low power, downsized switching power supplies, DC/DC converters and inverters, EMI/RFI noise suppression, and smoothing choke applications.

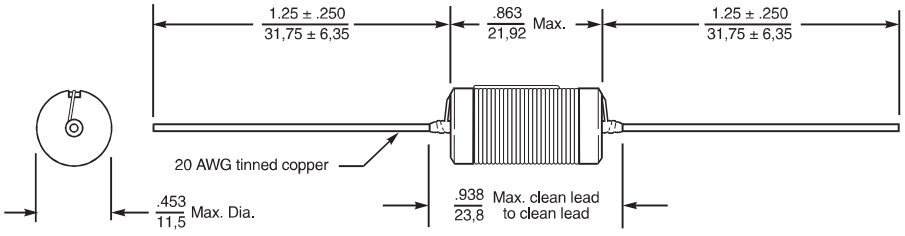
Coilcraft **Designer's Kit No. P209** contains samples of 30 standard parts (2 pieces each) from both series. To order, please contact Coilcraft.

- Wide inductance range in a low profile part
- High saturation current—up to 14.3 Amps DC
- Standard EIA or custom values
- Optional tape and reel packaging
- Designer's Kit of sample parts available
- Most values shipped from stock

PCH-27 SERIES



PCH-45 SERIES



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PCH-27 SERIES POWER CHOKES

Part Number	Inductance ± 10% Nom	SRF Typ (MHz)	DCR Max (Ohms)	Sat. Current (DC Amps)	Rated Current (AC Amps)
PCH-27-392	**3.9 µH**	**38**	**.017**	**7.01**	**1.7**
PCH-27-472	4.7	26	.024	6.16	1.3
PCH-27-562	5.6	25	.025	5.79	1.3
PCH-27-682	**6.8**	**25**	**.028**	**5.20**	**1.3**
PCH-27-822	8.2	22	.030	4.70	1.3
PCH-27-103	10	17	.033	4.30	1.3
PCH-27-123	**12**	**16**	**.037**	**3.80**	**1.3**
PCH-27-153	15	12	.041	3.41	1.3
PCH-27-183	18	11	.045	3.09	1.3
PCH-27-223	**22**	**10**	**.064**	**2.82**	**1.0**
PCH-27-273	27	7	.071	2.53	1.0
PCH-27-333	33	7	.078	2.29	1.0
PCH-27-393	**39**	**7**	**.085**	**2.09**	**1.0**
PCH-27-473	47	6	.094	1.88	1.0
PCH-27-563	56	6	.12	1.74	.84
PCH-27-683	**68**	**7**	**.16**	**1.57**	**.67**
PCH-27-823	82	4	.22	1.41	.52
PCH-27-104	100	3	.25	1.28	.52
PCH-27-124	**120**	**3**	**.35**	**1.17**	**.42**
PCH-27-154	150	3	.39	1.04	.42
PCH-27-184	180	3	.43	.943	.42
PCH-27-224	**220**	**3**	**.47**	**.848**	**.42**
PCH-27-274	270	2	.65	.764	.33
PCH-27-334	330	2	.72	.690	.33
PCH-27-394	**390**	**2**	**.78**	**.632**	**.33**
PCH-27-474	470	2	1.04	.573	.26
PCH-27-564	560	1	1.14	.520	.26
PCH-27-684	**680**	**1**	**1.49**	**.472**	**.21**
PCH-27-824	820	1	2.14	.427	.16
PCH-27-105	1.0 mH	1	2.36	.385	.16
PCH-27-125	**1.2**	**1**	**2.59**	**.350**	**.16**
PCH-27-155	1.5	.85	3.57	.312	.13
PCH-27-225	**2.2**	**.65**	**4.33**	**.255**	**.13**
PCH-27-275	2.7	.65	5.91	.229	.10
PCH-27-335	3.3	.60	8.63	.207	.083
PCH-27-395	**3.9**	**.60**	**9.38**	**.189**	**.083**
PCH-27-475	4.7	.50	10.3	.172	.083
PCH-27-565	5.6	.60	11.2	.157	.083
PCH-27-685	**6.8**	**.40**	**15.0**	**.142**	**.067**
PCH-27-825	8.2	.35	21.7	.128	.052
PCH-27-106	10	.30	24.0	.116	.052
PCH-27-126	**12**	**.25**	**33.2**	**.105**	**.040**
PCH-27-156	15	.30	47.2	.094	.031
PCH-27-186	18	.30	51.7	.085	.031

Parts in bold type are included in Coilcraft Designer's Kit P209.

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PCH-45 SERIES POWER CHOKES

Part Number	Inductance ± 10% Nom	SRF Typ (MHz)	DCR Max (Ohms)	Sat. Current (DC Amps)	Rated Current (AC Amps)
PCH-45-392	3.90 µH	34	.008	14.3	4.3
PCH-45-472	4.70	31	.009	13.0	4.3
PCH-45-562	5.60	29	.009	11.9	4.3
PCH-45-682	6.80	26	.010	11.0	4.3
PCH-45-822	8.20	23	.011	9.50	4.3
PCH-45-103	10.0	20	.012	8.93	4.3
PCH-45-123	12.0	17	.013	7.94	4.3
PCH-45-153	15.0	14	.015	7.15	4.3
PCH-45-183	18.0	11	.016	6.50	4.3
PCH-45-223	**22.0**	**10**	**.017**	**5.95**	**4.3**
PCH-45-273	27.0	9	.019	5.50	4.3
PCH-45-333	33.0	9	.021	4.93	4.3
PCH-45-393	**39.0**	**8**	**.025**	**4.46**	**4.3**
PCH-45-473	47.0	7	.035	4.08	3.4
PCH-45-563	56.0	6	.037	3.76	3.4
PCH-45-683	**68.0**	**5**	**.044**	**3.40**	**2.7**
PCH-45-823	82.0	4	.060	3.10	2.1
PCH-45-104	100	3	.086	2.80	1.7
PCH-45-124	**120**	**3**	**.095**	**2.55**	**1.7**
PCH-45-154	150	3	.14	2.30	1.3
PCH-45-184	180	2	.15	2.10	1.3
PCH-45-224	**220**	**2**	**.17**	**1.90**	**1.3**
PCH-45-274	270	2	.19	1.72	1.3
PCH-45-334	330	2	.21	1.55	1.3
PCH-45-394	**390**	**2**	**.26**	**1.43**	**1.0**
PCH-45-474	470	1	.32	1.30	1.0
PCH-45-564	560	1	.38	1.19	.84
PCH-45-684	**680**	**1**	**.51**	**1.08**	**.67**
PCH-45-824	820	1	.59	.986	.67
PCH-45-105	1.0 mH	1	.69	.893	.67
PCH-45-125	**1.2**	**1**	**.78**	**.817**	**.67**
PCH-45-155	1.5	.75	.92	.729	.67
PCH-45-225	2.2	.70	1.67	.600	.42
PCH-45-275	**2.7**	**.65**	**2.28**	**.543**	**.33**
PCH-45-335	3.3	.60	2.59	.491	.33
PCH-45-395	3.9	.55	2.87	.452	.33
PCH-45-475	**4.7**	**.50**	**3.22**	**.412**	**.33**
PCH-45-565	5.6	.40	4.25	.377	.26
PCH-45-685	6.8	.35	5.88	.342	.21
PCH-45-825	**8.2**	**.30**	**6.46**	**.311**	**.21**
PCH-45-106	10	.30	9.10	.282	.16
PCH-45-126	12	.30	9.99	.257	.16
PCH-45-156	**15**	**.30**	**11.2**	**.230**	**.16**
PCH-45-186	18	.20	15.2	.210	.13
PCH-45-226	22	.20	16.8	.190	.13
PCH-45-276	**27**	**.15**	**18.6**	**.171**	**.13**
PCH-45-336	33	.15	26.7	.155	.10
PCH-45-396	39	.15	29.0	.143	.10
PCH-45-476	**47**	**.10**	**31.8**	**.131**	**.10**
PCH-45-566	56	.10	42.6	.119	.083
PCH-45-686	68	.10	46.9	.108	.083
PCH-45-826	**82**	**.10**	**64.9**	**.098**	**.067**
PCH-45-107	100	.10	71.7	.099	.067

Parts in bold type are included in Coilcraft Designer's Kit P209.

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Power Inductors – DC1012 Series

These power inductors are especially effective as DC-DC converter boost or buck inductors and as output ripple filter chokes in all types of downsized switching power supplies.

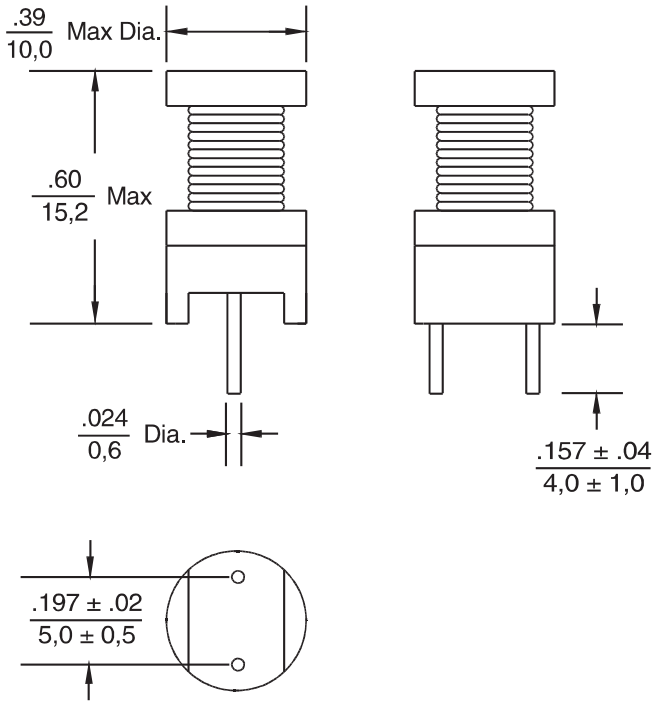
They are ideal for applications requiring small size, cost effective power inductors. The vertical style helps reduce power supply size by saving crucial printed circuit board area. The large inductance available per size makes these parts ideal for all sorts of energy storage, smoothing, and EMI reduction applications.

The Coilcraft DC1012 Series includes a wide range of EIA standard inductance values. Custom versions are also available.

Coilcraft **Designer's Kit P210** contains three samples of all the standard parts shown. To order, contact Coilcraft.

Specifications

Part Number	Inductance[1] 10% μH	DCR Max (Ω)	Current Rating[2] (Amps)
DC1012-103	10	.026	3.5
DC1012-123	12	.030	3.2
DC1012-153	15	.035	3.0
DC1012-183	18	.038	2.8
DC1012-223	22	.046	2.5
DC1012-273	27	.070	2.2
DC1012-333	33	.080	2.0
DC1012-393	39	.088	1.8
DC1012-473	47	.100	1.6
DC1012-563	56	.15	1.4
DC1012-683	68	.17	1.2
DC1012-823	82	.20	1.2
DC1012-104	100	.22	1.2
DC1012-124	120	.29	1.0
DC1012-154	150	.34	.9
DC1012-184	180	.38	.8
DC1012-224	220	.44	.7
DC1012-274	270	.62	.7
DC1012-334	330	.70	.6



1. Tested at 100 kHz, .1 Vrms.
2. Current rating is based on I^2R loss = 3/8 Watt Max. Inductance drop is 10% typ. at the rated current.

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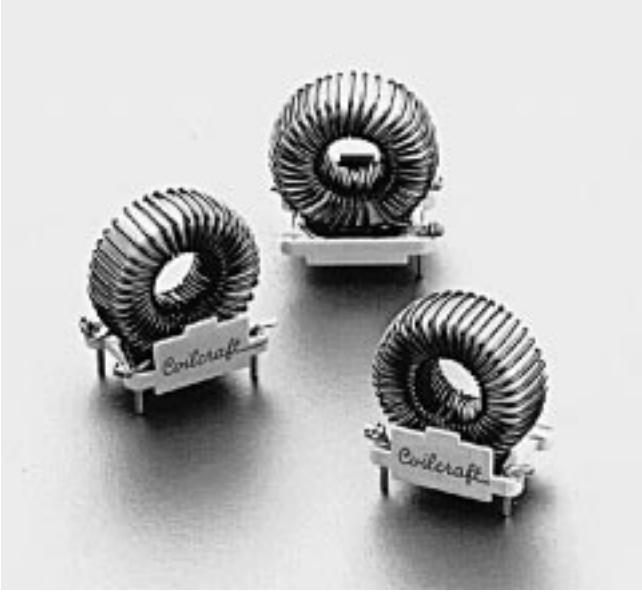
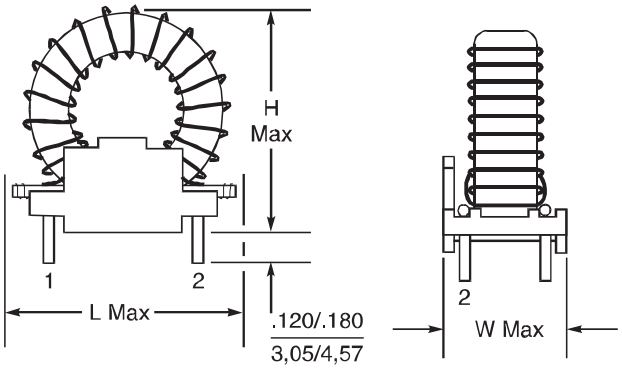
Output Power Chokes – Toroid Styles



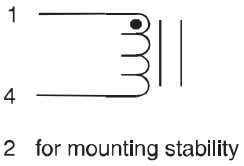
These power inductors are designed primarily for use as output chokes in switching power supplies. They feature small size and low cost. The toroid core design offers the most inductance in the smallest part size, while minimizing external magnetic fields.

These parts are suited for any application requiring a high DC current bias. The inductance values listed are for parts when tested at low (10 gauss) levels of AC excitation. The parts are very well suited for use at higher levels of AC excitation and will exhibit higher inductance.

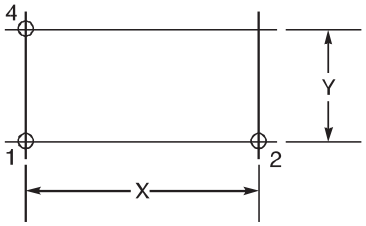
- All insulating materials 130°C or higher.
- Industry standard footprint.
- UL 1446 approved Insulation System available.
- All plastic material UL94V-0.



Schematic



Footprint



DMT1 Series

Part Number	Inductance Min (µH)	Current Rating (Amps)	R_{DC} Max (Ohms)	H Max	L Max	W Max	X ±.01/0,25	Y ±.01/0,25	Lead Diameter Nom
DMT1-180-1.5	180	1.5	.29	1.10/27,9	1.3/33,0	.7/17,8	.80/20,3	.40/10,2	.054/1,37
DMT1-84-2.4	84	2.4	.14	1.10/27,9	1.3/33,0	.7/17,8	.80/20,3	.40/10,2	.054/1,37
DMT1-43-3.8	43	3.8	.07	1.10/27,9	1.3/33,0	.7/17,8	.80/20,3	.40/10,2	.054/1,37
DMT1-26-5.1	26	5.1	.04	1.10/27,9	1.3/33,0	.7/17,8	.80/20,3	.40/10,2	.054/1,37
DMT1-16-6.7	16	6.7	.02	1.10/27,9	1.3/33,0	.7/17,8	.80/20,3	.40/10,2	.054/1,37
DMT1-7-10	7	10.0	.01	1.10/27,9	1.3/33,0	.7/17,8	.80/20,3	.40/10,2	.054/1,37

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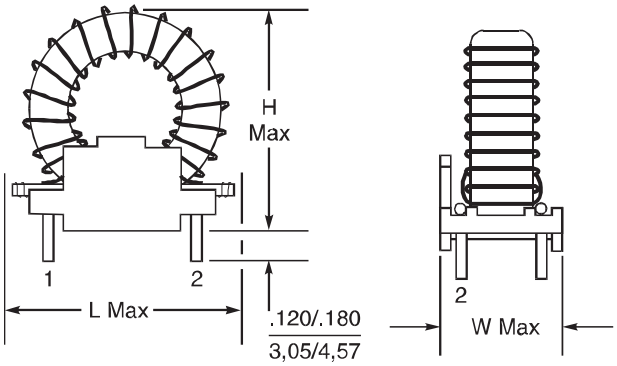
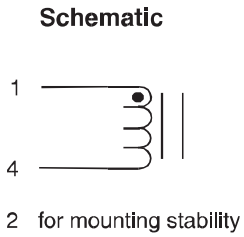
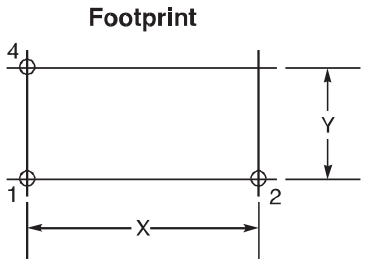
Output Power Chokes—Toroid Styles







DMT2 Series

Part Number	Inductance Min (µH)	Current Rating (Amps)	R_{DC} Max (Ohms)	H Max	L Max	W Max	X ±.01/0,25	Y ±.01/0,25	Lead Diameter Nom
DMT2-567-1.5	567	1.5	.56	1.4/35,6	1.4/35,6	.9/22,9	.90/22,8	.60/15,2	.054/1,37
DMT2-273-2.4	273	2.4	.26	1.4/35,6	1.4/35,6	.9/22,9	.90/22,8	.60/15,2	.054/1,37
DMT2-149-3.8	149	3.8	.13	1.4/35,6	1.4/35,6	.9/22,9	.90/22,8	.60/15,2	.054/1,37
DMT2-79-6.0	79	6.0	.07	1.4/35,6	1.4/35,6	.9/22,9	.90/22,8	.60/15,2	.054/1,37
DMT2-47-8.2	47	8.2	.04	1.4/35,6	1.4/35,6	.9/22,9	.90/22,8	.60/15,2	.054/1,37
DMT2-26-11	26	11.0	.02	1.4/35,6	1.4/35,6	.9/22,9	.90/22,8	.60/15,2	.054/1,37
DMT2-796-1.5	796	1.5	.79	1.6/40,6	1.6/40,6	.9/22,9	.90/22,8	.60/15,2	.054/1,37
DMT2-380-2.4	380	2.4	.38	1.6/40,6	1.6/40,6	.9/22,9	.90/22,8	.60/15,2	.054/1,37
DMT2-200-3.8	200	3.8	.19	1.6/40,6	1.6/40,6	.9/22,9	.90/22,8	.60/15,2	.054/1,37
DMT2-134-4.8	134	4.8	.10	1.6/40,6	1.6/40,6	.9/22,9	.90/22,8	.60/15,2	.054/1,37
DMT2-80-6.3	80	6.3	.05	1.75/44,5	1.7/43,2	.9/22,9	.90/22,8	.60/15,2	.054/1,37
DMT2-49-8.0	49	8.0	.03	1.6/40,6	1.6/40,6	.9/22,9	.90/22,8	.60/15,2	.054/1,37
DMT2-20-12	20	12.0	.02	1.7/43,2	1.6/40,6	.9/22,9	.90/22,8	.60/15,2	.054/1,37

DMT3 Series

Part Number	Inductance Min (µH)	Current Rating (Amps)	R_{DC} Max (Ohms)	H Max	L Max	W Max	X ±.01/0,25	Y ±.01/0,25	Lead Diameter Nom
DMT3-1439-1.5	1439	1.5	1.18	1.9/48,3	1.9/48,3	.95/24,1	1.2/30,5	.7/17,8	.054/1,37
DMT3-695-2.4	695	2.4	.55	1.9/48,3	1.9/48,3	.95/24,1	1.2/30,5	.7/17,8	.054/1,37
DMT3-402-3.7	402	3.7	.28	1.9/48,3	1.9/48,3	.95/24,1	1.2/30,5	.7/17,8	.054/1,37
DMT3-257-4.9	257	4.9	.15	1.9/48,3	1.9/48,3	.95/24,1	1.2/30,5	.7/17,8	.054/1,37
DMT3-138-6.0	138	6.0	.07	1.9/48,3	1.9/48,3	.95/24,1	1.2/30,5	.7/17,8	.054/1,37
DMT3-77-8.0	77	8.0	.04	1.9/48,3	1.9/48,3	.95/24,1	1.2/30,5	.7/17,8	.054/1,37
DMT3-35-12	35	12.0	.02	2.0/50,8	2.0/50,8	.95/24,1	1.2/30,5	.7/17,8	.054/1,37

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